ANNALES

Anali za istrske in mediteranske študije
Annali di Studi istriani e mediterranei
Annals for Istrian and Mediterranean Studies
Series Historia Naturalis, 12, 2002, 1

UDK 5 Annales, Ser. hist. nat., 12, 2002, 1, pp. 1-128, Koper 2002 ISSN 1408-533X

ANNALES

Anali za istrske in mediteranske študije
Annali di Studi istriani e mediterranei
Annals for Istrian and Mediterranean Studies
Series Historia Naturalis, 12, 2002, 1

UDK 5 Annales, Ser. hist. nat., 12, 2002, 1, pp. 1-128, Koper 2002 ISSN 1408-533X

1

2

3

4

5

6

7

8

ISSN 1408-533X

UDK 5

ISSN 1408-533X

ANNALES

Anali za istrske in mediteranske študije
Annali di Studi istriani e mediterranei
Annals for Istrian and Mediterranean Studies

series historia naturalis, 12, 2002, 1

KOPER 2002

Anali za istrske in mediteranske študije - Annali di Studi istriani e mediterranei - Annals for Istrian and Mediterranean Studies

Annales, Ser. hist. nat., 12, 2002, 1

ISSN 1408-533X UDK 5 Letnik 12, leto 2002, številka 1

Izdajatelja/*Editori/Published by:* Zgodovinsko društvo za južno Primorsko/Società storica del Litorale © - Znanstveno raziskovalno središče Republike Slovenije, Koper/*Centro di ricerche scientifiche della Repubblica di Slovenia, Capodistria/Science and Research Centre of the Republic of Slovenia, Koper* ©

Za izdajatelja/*Per gli Editori/* ***Publishers represented by:*** Salvator Žitko, dr. Darko Darovec

Sedež uredništva/ ***Sede della redazione/*** ***Address of Editorial Board:*** Znanstvenoraziskovalno središče Republike Slovenije, Koper, SI-6000 Koper/*Capodistria,* Garibaldijeva 18/ *Via Garibaldi 18,* p.p. /P.O. Box 612, tel.: + 386 5 6637700, fax: + 386 5 6637710;
e-mail: annales@zrs-kp.si, **internet:** http://www.zrs-kp.si/

Redakcija te številke je bila zaključena 10. oktobra 2002

Sofinancirajo/Supporto finanziario/ ***Financially supported by:*** Ministrstvo za šolstvo, znanost in šport Republike Slovenije, Mestna občina Koper, Občina Izola, Občina Piran ter drugi sponzorji.

Annales - series historia naturalis izhaja dvakrat letno.
Annales - series historia et sociologia izhaja dvakrat letno.

Letna naročnina za obe seriji je 7000 SIT, maloprodajna cena tega zvezka je 2500 SIT.

Nenaročenih rokopisov in drugega gradiva ne vračamo. Rokopise in naročnino sprejemamo na sedežu uredništva. Rokopise lahko pošiljate tudi članom uredništva.

Naklada/*Tiratura/Circulation:* 700 izvodov

Revija Annales series historia naturalis je vključena v naslednje podatkovne baze: Zoological Record (UK), Aquatic Sciences and Fisheries Abstracts (ASFA).

ANNALES · Ser. hist. nat. · 12 · 2002 · 1

Anali za istrske in mediteranske študije - Annali di Studi istriani e mediterranei - Annals for Istrian and Mediterranean Studies

UDK 5 Letnik 12, Koper 2002, številka 1 ISSN 1408-533X

VSEBINA / INDICE GENERALE / CONTENTS

IHTIOLOGIJA

ITTIOLOGIA

ICHTHYOLOGY

original scientific paper
received: 18. 9. 2002

UDC 591.5:597(262.3)

A VISUAL CENSUS OF THE COASTAL FISH ASSEMBLAGE AT KOSTRENA (THE KVARNER AREA, CROATIA)

Marcelo KOVAČIĆ
Prirodoslovni muzej Rijeka, HR-51000 Rijeka, Lorenzov prolaz 1
E-mail: Marcelo.Kovacic@public.srce.hr

ABSTRACT

The modified stationary visual census technique (point method or circular point method) was used to provide a preliminary description of fish assemblages at the locality of Kostrena (the Kvarner area, Croatia). A high number (52) of fish species was recorded. The results also showed strong influence of substrate composition and bottom depth on the fish community, at least on fish species composition. Samples grouped in cluster analysis in five habitat types based on similarity of bottom and depth characteristics. The community parameters between groups were significantly different.

Key words: fish assemblages, Adriatic Sea, visual census

VISUAL CENSUS DELLA COMUNITÀ ITTICA LITORALE DI KOSTRENA (AREA QUARNERINA, CROAZIA)

SINTESI

L'articolo riporta una descrizione preliminare delle comunità ittiche di Kostrena (area Quarnerina, Croazia), ottenuta con la tecnica del visual census, con l'utilizzo di un sistema fisso di osservazione. L'autore ha registrato un numero elevato di specie ittiche (52). I risultati indicano una forte influenza della composizione del substrato e della profondità dell'acqua sulla comunità ittica, almeno per quanto riguarda la natura delle specie. I campioni sono stati raggruppati in cinque tipi di habitat in base alle somiglianze delle caratteristiche di substrato e profondità, con l'uso della cluster analysis. I parametri di comunità differiscono significativamente tra i vari gruppi.

Parole chiave: comunità ittiche, mare Adriatico, visual census

INTRODUCTION

The marine area of the Kostrena municipality has been proposed for protection as a submarine park by the Primorsko-Goranska County. In order to prepare a proposal for the protection program, a thorough investigation of the geology and biology of sublittoral sea bottom of the Kostrena municipality was conducted. The Kostrena is recreational area with well preserved beaches and coastal zone, but situated in the northern part of the Rijeka Bay, which is heavily polluted by domestic and industrial waste (Fig. 1). According to Jardas *et al.* (1998), there are no published data on coastal fish assemblage at Kostrena.

The main aim of the ichthyological investigation was to provide a preliminary description of fish assemblages at the locality of Kostrena; consequently, the visual census method was chosen as the one best suited to this aim.

MATERIAL AND METHODS

The geomorphological, sedimentological, biocenological and ichthyological researches were carried out at four locations (KO1, KO2, KO3, KO4) (Fig. 1) in the summer of 1999, from July to August. Modified stationary visual census technique (Bohnsack & Bannerot, 1986, also named point method by Bortone *et al.*, 1989 or circular point method by Francour, 1997) was applied. The point method advantages were listed in Bohnsack & Bannerot (1986). However, the main reasons for point method in this research were steep bottom, habitat changes along with depth and habitat patchiness (heterogeneity). At the four locations (KO1, KO2, KO3, KO4) (Fig. 1), visual fish censuses were performed at the depths of 0, 2.5, 5, 7.5, 10, 15, 20, 25, 30, 35 and 40 m during morning hours. Bottom characteristics at different depth points were recorded, and bottom type classified as soft bottom (sand, muddy sand with <1/6 of surface consisting of cobbles, boulders and bedrock), mixed bottom and rocky bottom (cobbles, boulders and bedrock with <1/6 of surface covered with sand). The phytal cover was not taken into consideration. However, the algal cover at all four locations was poorly developed and erected macroalgae or seagrass were not present. The largest depths were not reached at KO1 (40 m) and KO4 positions (30 m, 35 m, 40 m). Altogether, a total of 40 point counts were carried out (KO1: 10, KO2: 11, KO3: 11, KO4: 8). Diver rotated at a point making a full circle (360°) during 5 minutes and counted the fishes occurring in his visual field within a defined area. Hyperbenthic and benthopelagic fishes were counted within a circular area of 4 m radius (50 m^2), and epibenthic fishes within a circular area of 1.8 m radius (10 m^2). Counting areas smaller than usual (Bohnsack & Bannerot, 1986, Bortone *et al.*, 1989; Francour, 1996) were chosen because of the high relief, which covered the visual field, especially for small ephibenthic species. A marked line was used to estimate the radius. All chosen depths were taken as a centre of the counting area, except at 0 m where this point was in fact the edge of the counting area. Fishes were counted according to the abundance scale based on a basic geometric progression factor of 2 (1, 2-5, 6-10, 11-30, 31-50, 51-100, >100). According to Bohnsack & Bannerot (1986), the density of fishes, expressed as the number of individuals per 10 m^2, was considered an index and not an absolute datum.

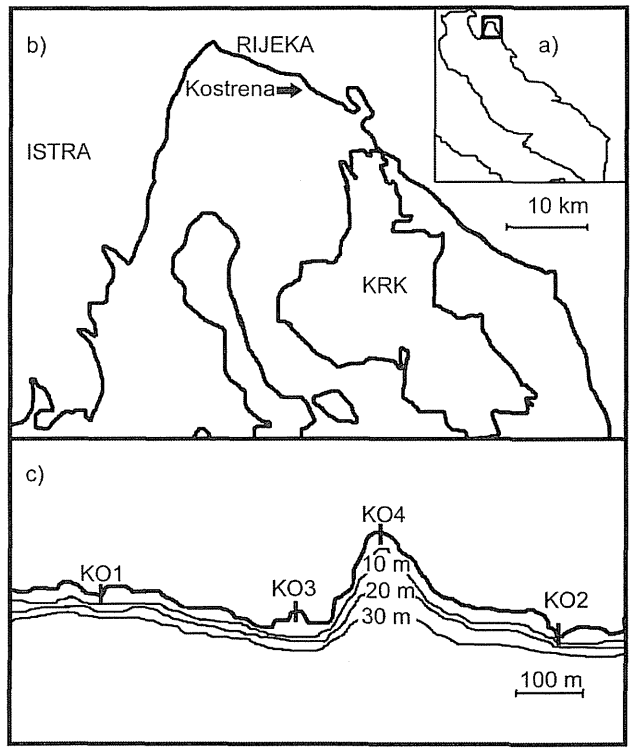


Fig. 1: Sampling area: a) the Adriatic Sea, b) the Kvarner area, c) the Kostrena coast with investigated KO1-KO4 locations.
Sl. 1: Vzorčišče: a) Jadransko morje, b) Kvarner, c) kostrensko obrežje z raziskanimi lokacijami KO1-KO4.

Qualitative affinities between samples were studied by means of the Jaccard similarity index (Krebs, 1989), using the centroid method for hierarchial classification analysis. Abundance data were compiled for each group of samples from cluster analysis, and the following community parameters were calculated: mean species number, mean individuals number and species diversity (the Shannon-Wiener diversity index H' according to Krebs, 1989). The significance of the differences of community parameters among groups was tested statistically using the non-parametric Kruskal-Wallis test.

Tab. 1: List of recorded fish species with quantitative data: a)-f), pooled samples based on cluster analysis, bottom and depth characteristics explained in text; mean±s.d., mean abundance with standard deviation; F%, frequency of occurrence. Underlined species are those observed out of the counting points during SCUBA divings.
Tab. 1: Seznam zabeleženih ribjih vrst s kvanitativnimi podatki: a)-f), podatki, zbrani na osnovi grozdičaste analize, pridnene in globinske značilnosti pojasnjene v besedilu; sred.±s.d., srednja gostota s standardno deviacijo; F%, frekvenca pojavljanja. Podrčrtane vrste so zunaj števnih točk opazili potapljači.

	a) & b)		c)		d)		e)		f)	
Species	mean±s.d.	F%	mean±s.d.	F%	mean±s.d.	F%	mean±s.d.	F%	mean±s.d.	F%
Aidablennius sphynx (Valenciennes, 1836)	0.13±0.35	12.5	0	0	0	0	0	0	0	0
Atherina sp.	2.5±7.07	12.5	2.22±6.67	11.1	0	0	0	0	0	0
Boops boops (Linnaeus, 1758)	0	0	3.28±6.79	33.3	5.45±7.85	45.5	5±9.26	25	0	0
Buenia affinis Iljin, 1930	0	0	0	0	0	0	0.25±0.46	25	0	0
Chromis chromis (Linnaeus, 1758)	0.4±0.7	25	2.02±2.55	77.8	2.25±3.24	45.5	0	0	0	0
Coris julis (Linnaeus, 1758)	1.16±1.3	75	1.28±1.16	88.9	0.47±0.61	63.6	0.13±0.1	62.5	0	0
Diplodus annularis (Linnaeus, 1758)	0	0	0.09±0.11	44.4	0	0	0	0	0	0
Diplodus puntazzo (Cetti, 1777)	0	0	0.02±0.07	11.1	0	0	0	0	0	0
Diplodus sargus sargus (Linnaeus, 1758)	0.08±0.10	37.5	0.02±0.07	11.1	0	0	0	0	0	0
Diplodus vulgaris (E. Geoffroy Saint-Hilaire, 1817)	0.03±0.07	12.5	0.12±0.23	33.3	0	0	0	0	0	0
Gobius bucchichi (Steindachner, 1870)	1.38±1.38	75	0.22±0.44	22.2	0	0	0.13±0.35	12.5	0	0
Gobius cobitis Pallas, 1811	0.25±0.46	25	0	0	0	0	0	0	0	0
Gobius cruentatus Gmelin, 1789	0	0	0.33±0.5	33.3	0	0	0	0	0	0
Gobius geniporus Valenciennes, 1837	0	0	0.11±0.33	11.1	0.09±0.31	9.1	0.13±0.35	12.5	0	0
Gobius roulei De Buen, 1928	0	0	0	0	0.18±0.41	18.2	2±1.65	75	1.63±1.25	100
Gobius vittatus Vinciguerra, 1883	0	0	1.56±0.37	100	1.81±1.37	90.1	0	0	0	0
Gobius xanthocephalus Zander & Heymer, 1992	0	0	0.33±0.5	33.3	0.18±0.41	18.2	0	0	0	0
Labrus bimaculatus Linnaeus, 1758	0	0	0	0	0.09±0.30	9.1	0	0	0	0
Lipophrys canevai (Vinciquerra, 1880)	0.25±0.46	25	0	0	0	0	0	0	0	0
Oblada melanura (Linnaeus, 1758)	3.51±6.79	75	1.1±1.29	77.8	0.06±0.21	9.1	0	0	0	0
Parablennius gattorugine (Brunnich, 1788)	0	0	0	0	0.09±0.3	9.1	0	0	0	0
Parablennius incognitus (Bath, 1968)	0.38±0.52	37.5	0.11±0.33	11.1	0	0	0	0	0	0
Parablennius rouxi (Cocco, 1833)	0.25±0.46	25	1.56±1.1	100	1.27±1.17	81.8	0.13±0.35	12.5	0	0
Parablennius sanguinolentus (Pallas, 1811)	0.38±0.52	37.5	0.11±0.33	11.1	0	0	0	0	0	0
Parablennius tentacularis (Brunnich, 1788)	0	0	0	0	0	0	0.13±0.35	12.5	0	0
Parablennius zvonimiri (Kolombatović, 1892)	0.63±0.52	62.5	0	0	0.09±0.31	9.1	0	0	0	0
Sarpa salpa (Linnaeus, 1758)	0.18±0.32	25	0.8±1.39	33.3	0.06±0.21	9.1	0	0	0	0
Scorpaena porcus Linnaeus, 1758	0	0	0	0	0.18±0.41	18.2	0	0	0	0
Serranus hepatus (Linnaeus, 1758)	0	0	0.09±0.11	44.4	0.15±0.09	72.7	0.13±0.1	62.5	0	0
Serranus scriba (Linnaeus, 1758)	0.05±0.09	25	0.04±0.09	22.2	0	0	0	0	0	0
Speleogobius trigloides Zander & Jelinek, 1976	0	0	0	0	0.59±1.07	36.4	0	0	0	0
Spicara maena (Linnaeus, 1758)	0	0	0	0	0.36±1.21	9.1	0	0	0	0
Spicara smaris (Linnaeus, 1758)	0	0	1.88±3.48	44.4	0.35±0.65	27.3	0	0	0	0
Spondyliosoma cantharus (Linnaeus, 1758)	0	0	0.02±0.07	11.1	0	0	0	0	0	0
Symphodus (Crenilabrus) cinereus (Bonaterre, 1788)	0	0	0	0	0	0	0.03±0.07	12.5	0	0
Symphodus (Crenilabrus) mediterraneus (Linnaeus, 1758)	0	0	0	0	0.04±0.08	18.2	0	0	0	0
Symphodus (Crenilabrus) ocellatus (Forskal, 1775)	0.03±0.07	12.5	0.09±0.11	44.4	0	0	0	0	0	0
Symphodus (Crenilabrus) tinca (Linnaeus, 1758)	0.03±0.07	12.5	0.16±0.09	77.8	0	0	0	0	0	0
Thorogobius ephippiatus (Lowe, 1839)	0	0	0	0	0.36±0.5	36.4	0	0	0	0
Thorogobius macrolepis (Kolombatović, 1891)	0	0	0.11±0.33	11.1	0.96±0.96	72.7	0.13±0.35	12.5	0	0
Tripterygion delaisi Cadenat & Blache, 1971	0	0	0.22±0.44	22.2	0.36±0.5	36.4	0	0	0	0
Tripterygion tripteronotus (Risso, 1810)	0.38±0.52	37.5	0	0	0	0	0	0	0	0
Chromogobius quadrivittatus (Steindachner, 1863)										
Dicentrarchus labrax (Linnaeus, 1758)										
Gobius paganellus Linnaeus, 1758										
Lepadogaster candolei Risso, 1810										
Lepadogaster lepadogaster lepadogaster (Bonaterre, 1788)										
Lipophrys dalmatinus (Steindachner & Kolombatović, 1883)										
Lipophrys nigriceps (Vinciguerra, 1883)										
Scorpaena notata Rafinesque, 1810										
Tripterygion melanurus minor Kolombatović, 1982										
Zebrus zebrus (Risso, 1810)										
Number of point counts	8		9		11		8		4	
Mean number of species	6.5±2.6		9.88±2.22		7.45±1.86		3.25±1.67		1	
Mean number of individuals	11.95±10.02		19.04±8.61		15.47±10.55		8.15±8.67		1.63+1.25	
Species diversity	1.91±0.4		2.33±0.70		2.3±0.51		1.22±0.71		/	
Total number of species	19		26		22		11		1	

Mann-Whitney U-test was used for multiple comparisons (Sokal & Rohlf, 1995). Cluster analysis and tests of significance were carried out by the SPSS 9.0 program. The Shannon-Wiener diversity index was calculated by the use of Ecological methodology 5.2 program (C. J. Krebs, 2000: Programs for Ecological Methodology, 2nd ed.).

RESULTS

A total of 52 fish species were recorded, 42 were censused during point counts, while others were randomly observed during the same SCUBA divings (Tab. 1). The dominant families in terms of species number

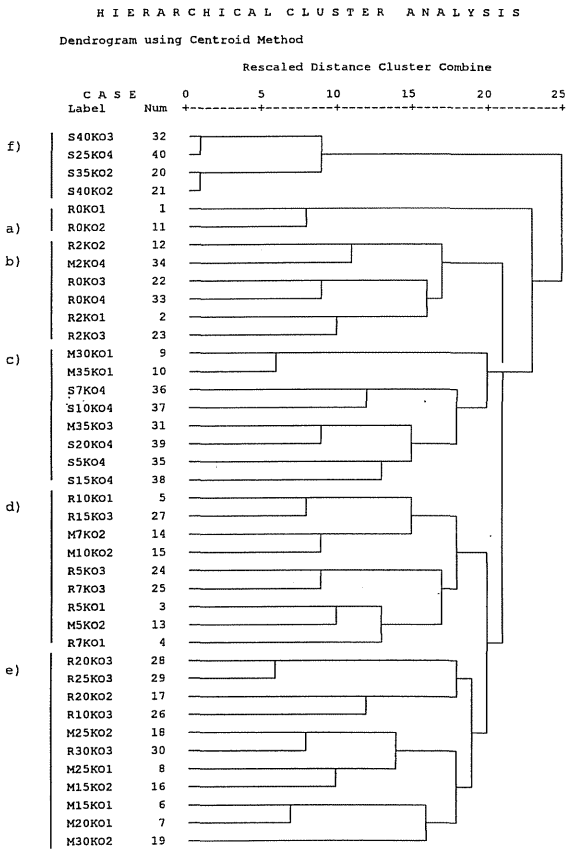


Fig. 2: Cluster analysis between visual census samples. Similarity index of Jaccard and centroid method for hierarchical classification analysis. R: rocky bottom, M: mixed bottom, S: sandy bottom; 0-40: depth (m); KO1-KO4: locations.
Sl. 2: Grozdičasta analiza med vzorci vizualnega štetja. Jaccardov indeks podobnosti in centroidna metoda za analizo hierarhične razvrstitve. R: kamnito dno, M: mešano dno, S: peščeno dno; 0-40: globina (m); KO1-KO4: lokalitete.

Mean species number / *Srednje št. vrst*	ab	c	d
e	*	*	*
d		*	
c	*		

Mean individuals number / *Srednje št. osebkov*	ab	c	d
e	*	*	*
d			
c			

Species diversity / *Diverziteta vrst*	ab	c	d
e		*	*
d			
c			

Fig. 3: Results of Mann-Whitney U-test for multiple comparisons of mean fish species number, mean individuals number and species diversity between pooled samples based on cluster analysis (a-e). The bottom and depth characteristics explained in text.
**** - denotes significant difference (P<0.05) between two groups of samples.***
Sl. 3: Rezultati Mann-Whitneyevega U-testa za večkratne primerjave srednjega števila ribjih vrst, srednjega števila osebkov in diverziteto vrst med vzorci, zbrani na osnovi grozdičaste analize (a-e). Pridnene in globinske značilnosti so pojasnjene v besedilu.
**** - ponazarja pomembno razliko (P<0.05) med dvema skupinama vzorcev.***

were Gobiidae (14 species) and Blenniidae (10 species). Hierarchical classification analysis among the Kostrena samples showed grouping of samples based on similar bottom and depth characteristics (Fig. 2). Six main clusters belonged to five habitat types with the following depth and substrata characteristics: a) and b) rocky bottom 0-2.5 m depth, c) rocky and mixed bottom at 5-10 m depth (except for the counting point R15KO3), d) rocky and mixed bottom at 15-30 m depth (except for the counting point R10KO3), e) sandy bottom at 5-20 m depth and mixed bottom at 30-35 m depth, and f) sandy bottom at 25-40 m depth (Fig. 2). Poorly inhabited sandy bottom at 25-40 m depth clearly differed in quantitative characteristics of fish assemblages from all other habitats (Tab. 1). The community parameters between the four remaining groups were significantly different (Kruskal-Wallis = 20.52 in species richness, 11.43 in abundance and 9.1 in species diversity, all $P<0.05$). Habitats differ significantly in species richness except for

habitats ab) and d) (Mann-Whitney U-test, Fig. 3). Fish density was significantly lower only in habitat e) compared to all other tested habitats. The habitat e) also showed significant differences from habitats c) and d) in species diversity (Mann-Whitney U-test, Fig. 3). The most common and abundant ephibenthic fish species during the visual census at Kostrena were: *Gobius bucchichi* in shallow water, *Gobius vittatus* and *Parablennius rouxi* on the rocky bottom of ≥5 m depth, with *Thorogobius macrolepis* of ≥15 m depth as well (Tab. 1), and *Gobius roulei* on the sandy bottom. Among hyperbenthic and benthopelagic species, *Atherina* sp., *Coris julis* and *Oblada melanura* were the most common and most abundant fishes in shallow infralittoral, while *Boops boops* and *Chromis chromis* were the most common and most abundant fishes in deeper infralittoral. The high density of these two groups overlapped between 5-10 m depth (Tab. 1).

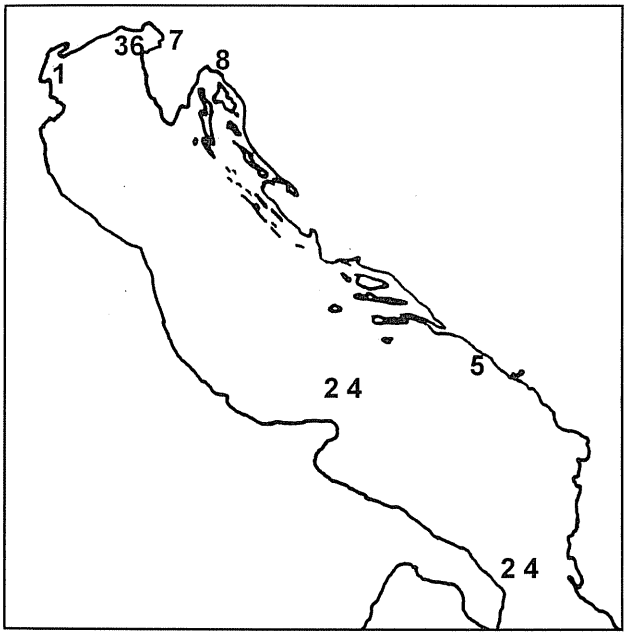


Fig. 4: Available data on visual census of fish assemblages in the Adriatic Sea: 1 - Marconato** et al., **1996; 2 - Fasola** et al., **1997; 3 - De Girolamo** et al., **1998; 4 - Guidetti, 2000; 5 - Guidetti & Bussotti, 2000; 6 - Castellarin** et al., **2001; 7 - Lipej & Orlando Bonaca,** in prep.; **8 - the present research.
Sl. 4: Razpoložljivi podatki o vizualnem štetju ribjih združb v Jadranskem morju: 1 - Marconato** et al., **1996; 2 - Fasola** et al., **1997; 3 - De Girolamo** et al., **1998; 4 - Guidetti, 2000; 5 - Guidetti & Bussotti, 2000; 6 - Castellarin** et al., **2001; 7 - Lipej & Orlando Bonaca,** in prep.; **8 – pričujoče raziskave.

DISCUSSION

The present visual count of fishes is one of only a few performed visual counts of fish assemblages in the Adriatic Sea (Marconato *et al.*, 1996; Fasola *et al.*, 1997; De Girolamo *et al.*, 1998; Guidetti, 2000; Guidetti & Bussotti, 2000; Castellarin *et al.*, 2001; Lipej & Orlando Bonaca, *in preparation*)(Fig. 4). The present preliminary observation on the fish community was conducted on too small sample to provide an estimate of the absolute abundance of fish species at the Kostrena locality. However, it is a good qualitative description of fish assemblages and clearly shows the most numerous fish species in the habitats during the summer when the visual counts were carried out. It is difficult to compare the most numerous fish species with other published visual census results in the same zoogeographic area (the northern Adriatic). Marconato *et al.* (1996) and De Girolamo *et al.* (1998) did not give any details on fish species abundance. Castellarin *et al.* (2001) performed visual counts only in shallow water (<5 m depth). The most numerous fishes in their results during summer months were hyperbenthic and benthopelagic *Atherina* spp. and *O. melanura*, but also several other species not recorded, or at least not common at Kostrena (*Mugil cephalus, Sparus aurata, Sciaena umbra, Sarpa salpa*). *Coris julis*, abundant in shallow waters at Kostrena, were not mentioned in their list. *Gobius cruentatus* were similarly abundant as *G. bucchichi* among epibenthic species. The present data with 40 point counts show a surprisingly high number of fish species, compared to other published results of visual counts in the Mediterranean, often conducted on much larger samples, and combined with other sampling techniques (Francour *et al.*, 1995, 332 counts and 38 fish species; Harmelin-Vivien *et al.*, 1996 with 1081 visual counts and 48 fish species; Vacchi *et al.*, 1998 with 129 visual counts and 48 fish species). Only a few researches recorded larger species richness by SCUBA diving (Harmelin *et al.*, 1995; Mazzoldi & De Girolamo, 1997; La Mesa & Vacchi, 1999; Lipej & Orlando Bonaca, *in preparation*). The noted species richness during the present research was caused by a high number of found Blenniid and Gobiid species, reached in the visual counts of Mediterranean fish assemblages only by Mazzoldi & De Girolamo (1997), Castellarin *et al.* (2001) and Lipej & Orlando Bonaca (*in preparation*). It is more likely that the small epibenthic fishes, especially gobies, are underestimated in the Mediterranean visual censuses in general, than that the fish assemblages at Kostrena are especially rich in gobiid fauna. Several species of presently found gobiids are still known only from a few published records: *Buenia affinis, G. roulei, Speleogobius trigloides, T. macrolepis* (Kovačič, 1995, 1997, 2002; Ahnelt & Kovačić, 1997). *Speleogobius trigloides* was discovered and described from cave habitat (Zander & Jelinek,

1976). However, later findings were at open bottom surfaces (Kovačić, 1997; Fesser, 1980; this work). The papers publishing comparisons of visual census data from different infralittoral habitats or depths in the Mediterranean are rare. Guidetti (2000) compared fish assemblages at rocky bottoms, *Posidonia* meadows and bare sands. He came to similar results as the present study of higher species richness and fish density on rocky reef habitats than on bare sandy bottoms. Other papers compared visual census data between different seagrass meadows (Bussotti & Guidetti, 1999), bottoms with presence or absence of *Caulerpa* (Francour *et al.*, 1995; Harmelin-Vivien *et al.*, 1996), or rocky bottoms with or without erect macroalgal cover (Guidetti & Bussotti, 2000). Several papers with visual census data from two or three defined depths in the Mediterranean have been published (Francour, 1994; Francour *et al.*, 1995; Mazzoldi & De Girolamo, 1997; Vacchi *et al.*, 1998; La Mesa & Vacchi, 1999). However, due to the purpose of these papers, little attention was paid to comparisons of species composition and the community parameters among different depths. La Mesa & Vacchi (1999) observed that community parameters increased significantly with depth from shallow (3-5 m), intermediate (10-15) m to the deep transect (25-30 m), while the present research points out a significantly higher richness of species at medium infralittoral depths.

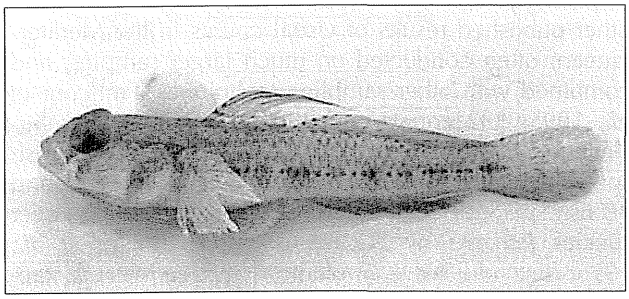


Fig. 5: Gobius roulei. (Photo/Foto: M. Kovačić)

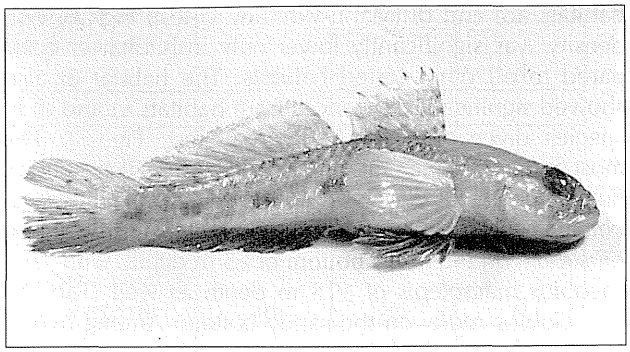


Fig. 6: Thorogobius macrolepis. (Photo/Foto: M. Kovačić)

CONCLUSIONS

The results of the preliminary observation of the fish community, especially the high number of fish species, justify the proposal to establish a protected area at the Kostrena locality. The results also showed strong influence of substrate composition and bottom depth on the fish community, at least on fish species composition. The absence of large species of rocky habitat (*Labrus* spp., *Sciaena umbra, Scorpaena scrofa*) in the studied area could have been caused by the anthropogenic factors on the fish community (overfishing and disturbance). However, the influence of the methodology of visual counts with defined and, for large fishes, relatively small, surface can not be excluded. The future use of the random visual census technique or the total count visual census technique could resolve this dilemma. The majority of numerously found epibenthic gobiids are connected with the availability of cracks and crevices, whereas poorly presented hyperbenthic wrasses (fam. Labridae) prefer dense cover of erected macroalgae or seagrass.

ACKNOWLEDGEMENTS

Diving assistance was provided by M. Arko Pijevac, Č. Benac and M. Kirinčić. I thank L. Lipej for his critical reading of the paper.

VIZUALNO ŠTETJE PRIOBALNIH RIBJIH ZDRUŽB V KOSTRENI (KVARNER, HRVAŠKA)

Marcelo KOVAČIĆ
Prirodoslovni muzej Rijeka, HR-51000 Rijeka, Lorenzov prolaz 1
E-mail: Marcelo.Kovacic@public.srce.hr

POVZETEK

Za predhodni opis ribjih združb na štirih lokalitetah v Kostreni (Kvarner, Hrvaška) v poletnih mesecih (juliju in avgustu) leta 1999 je bila uporabljena metoda vizualnega štetja rib, in sicer modificirana stacionarna tehnika štetja (točkovna ali krožna točkovna metoda). Rezultati predhodnega opazovanja ribjih združb opravičujejo načrt ustanovitve zaščitenega območja na tej lokaliteti. Pričujoči podatki kažejo na presenetljivo visoko število ribjih vrst v primerjavi z drugimi objavljenimi rezultati vizualnih štetij v Sredozemlju, ki so bila pogosto opravljena na neprimerno večjih vzrocih in kombinirana z drugimi tehnikami vzorčenja. Zabeleženih je bilo 52 ribjih vrst, 42 med točkovnim štetjem, druge pa naključno med potopi, ki jih je opravila skupinica potapljačev. Na morskem dnu, bogatem s špranjami in drugimi ribjimi zavetišči, a brez gostega pokrova makroalg ali morske trave, so bile zabeležene mnoge male efibentoške vrste (družini Gobiidae in Blenniidae). Rezultati pričajo tudi o močnem vplivu sestave matične podlage in globine dna na ribjo skupnost – ali vsaj na sestavo ribjih vrst. Po tako imenovani grozdičasti analizi so bili primerki razvrščeni v pet habitatnih tipov, temelječih na podobnostih v značilnostih dna in globine. Parametri združb med posameznimi skupinami so se močno razlikovali.

Ključne besede: ribje združbe, Jadransko morje, vizualno štetje

REFERENCES

Ahnelt, H. & M. Kovačić (1997): A northern Adriatic population of *Thorogobius macrolepis* (Gobiidae). Cybium, 21(2), 149-162.

Bohnsack, J. A. & S. P. Bannerot (1986): A stationary visual census technique for quantitatively assessing community structure of coral reef fishes. U.S. Dept. Commerce, NOAA Tech. Rept. NMFS, 41, 1-15.

Bortone, S. A., J. J. Kimmel & C. M. Bundrick (1989): A comparison of three methods for visually assessing reef fish communities: time and area compensated. Northeast Gulf Sci., 10(2), 85-96.

Bussotti, S. & P. Guidetti (1999): Fish communities associated with different seagrass systems in the Mediterranean Sea. Naturalista sicil., 23, 245-259.

Castellarin, C., G. Visintin & R. Odorico (2001): L'ittiofauna della Riserva Naturale Marina di Miramare (Golfo di Trieste, Alto Adriatico). Annales, Ser. hist. nat., 11, 207-216.

De Girolamo, M., S. Stefanni, C. Mazzoldi & R. Odorico (1999): Effetti della totale proibizione della pesca sul popolamento ittico del Parco marino di Miramare (TS): analisi preliminare. Supplemento al Bollettino del Museo civico di Storia naturale di Venezia, 49, 311-315.

Fasola, M., L. Canova, F. Foschi, O. Novelli & M. Bressan (1997): Resource Use by a Mediterranean Rocky Slope Fish Assemblage. P.S.Z.N.I. Mar. Ecol., 18(1), 51-66.

Fesser, R. (1980): Zusätzliche Beschreibung von *Speleogobius trigloides* Zander & Jelinek (1976) (Gobiidae, Perciformes), sowie neue Fundorte und Freilandbeobachtungen. Verhandlungen der Zoologisch-Botanischen Gesellschaft in Wien, 118/119, 123-125.

Francour, P. (1994): Pluriannual analysis of the reserve effect on ichthyofauna in the Scandola natural reserve (Corsica, Northwestern Mediterranean). Oceanol. Acta, 17(3), 309-317.

Francour, P. (1997): Fish Assemblages of *Posidonia oceanica* Beds at Port-Cros (France, NW Mediterranean): Assessment of Composition and Long-Term Fluctuations by Visual Census. P.S.Z.N.I. Mar. Ecol., 18(2), 157-173.

Francour, P., M. Harmelin-Vivien & J. G. Harmelin (1995): Impact of *Caulerpa taxifolia* colonization on the littoral ichthyofauna of North-Western Mediterranean sea: preliminary results. Hydrobiologia, 300/301, 345-353.

Guidetti, P. (2000): Differences Among Fish Assemblages Associated with Nearshore *Posidonia oceanica* Seagrass Beds, Rocky-algal Reefs and Unvegetated Sand Habitats in the Adriatic Sea. Estuar., Coast. Shelf Sci., 50, 515-529.

Guidetti, P & S. Bussotti (2000): Nearshore fish assemblages associated with shallow rocky habitats along the Southern Croatian coast (Eastern Adriatic Sea). Vie et Milieu, 50(3), 171-176.

Harmelin, J. G., F. Bachet & F. Garcia (1995): Mediterranean Marine Reserves: Fish Indices as Tests of Protection Efficiency. P.S.Z.N.I. Mar. Ecol., 16(3), 233-250.

Harmelin-Vivien, M., J. G. Harmelin & P. Francour (1996): A 3-year study of the littoral fish fauna of sites colonized by *Caulerpa taxifolia* in the N.W. Mediterranean (Menton, France). In: Ribera, M. A., E. Ballestros, C. F. Boudouresque, A. Gomez & V. Gravez (eds.): 2nd International Workshop on *Caulerpa taxifolia*. Publicacions Universitat Barcelona, p. 391-397.

Jardas, I., A. Pallaoro & M. Kovačić (1998): Recent ichthyofauna of Rijeka Bay. In: Arko-Pijevac, M., M. Kovačić & D. Crnković (eds.): Zbornik radova Prirodoslovna istraživanja riječkog područja. Prirodoslovni muzej Rijeka, Rijeka, p. 671-685.

Krebs, C. J. (1989): Ecological Methodology. Harper Collins Publishers, Inc., New York, 654 pp.

Kovačić, M. (1995): *Gobius roulei* De Buen, 1928 (Pisces, Teleostei, Gobiidae), a fish new to the Adriatic fauna. Natura Croatica, 4(4), 173-184.

Kovačić, M. (1997): Cryptobenthic gobies and clingfishes in the Kvarner area, Adriatic Sea. Natura Croatica, 6(4), 423-435.

Kovačić, M. (2002): A northern Adriatic population of *Buenia affinis* (Gobiidae). Cybium, 26, *(in press).*

Marconato, A., C. Mazzoldi, M. De Girolamo, S. Stefanni & G. Maio (1996): L'uso del "visual census" nello studio della fauna ittica costiera. Biol. Mar. Medit, 3(1), 512-513.

La Mesa, G. & M. Vacchi (1999): An Analysis of the Coastal Fish Assemblage of the Ustica Island Marine Reserve (Mediterranean Sea). P.S.Z.N.I. Mar. Ecol., 20(2), 147-165.

Lipej, L. & M. Orlando Bonaca (2002): Coastal fish diversity in three marine protected areas in the Gulf of Trieste (Northern Adriatic). *(in prep.)*

Mazzoldi, C. & M. De Girolamo (1997): Littoral fish community of the Island Lampedusa (Italy): a visual census approach. Ital. J. Zool., 65, Suppl., 275-280.

Sokal, R.R. & F.J. Rohlf (1995): Biometry. W. H. Freeman and company, New York, 850 pp.

Vacchi, M., S. Bussotti, P. Guidetti & G. La Mesa (1998): Study of the coastal fish assemblage in the marine reserve of the Ustica Island (southern Tyrrhenian Sea). Ital. J. Zool., 65, Suppl., 281-286.

Zander, C. D. & H. J. Jelinek (1976): Zur demersen Fischfauna im Bereich der Grotte von Banjole (Rovinj/YU) mit Beschreibung von *Speleogobius trigloides* n. gen. n. sp. (Gobiidae, Perciformes). Mitt. Hamburg. Zool. Mus. Inst., 73, 265-280.

original scientific paper
received: 11. 3. 2002

UDC 597.5:591.13(262.3-11)

FEEDING HABITS OF THE STRIPED RED MULLET, *MULLUS SURMULETUS* LINNAEUS, 1758, IN THE EASTERN CENTRAL ADRIATIC

Jakov DULČIĆ
Institute of Oceanography and Fisheries, HR-21000 Split, P.O. Box 500
E-mail: dulcic@izor.hr

ABSTRACT

The feeding habits of the striped red mullet Mullus surmuletus *in the eastern central Adriatic, in respect of season and fish size, were examined. Stomach contents of 348 specimens, 58 to 250 mm TL, collected by beach seine (called migavica) from July 1993 to June 1994, were analysed. Feeding intensity was high throughout the study period and varied significantly between the size classes. Mysidacea predominated in the mullet's diet. The composition of the prey ingested varied with predator size. Fish and cephalopods occurred exclusively in the diet of specimens larger than 185 mm TL. Diets varied seasonally. Amphipods were the most important prey group in winter and spring. Decapod crustaceans predominated during the summer, Mysidacea during the autumn. The results indicated that the striped red mullet fed on narrow range of prey items and could be considered a specialist.*

Key words: *Mullus surmuletus*, feeding habits, ontogeny, central Adriatic

ABITUDINI ALIMENTARI DELLA TRIGLIA DI SCOGLIO *MULLUS SURMULETUS* LINNAEUS, 1758, IN ADRIATICO CENTRO-ORIENTALE

SINTESI

Nell'articolo vengono esaminate le abitudini alimentari della triglia di scoglio Mullus surmuletus *dell'Adriatico centro-orientale in relazione alla stagionalità e alle dimensioni del pesce. È stato analizzato il contenuto stomacale di 348 individui, da 58 a 250 mm di lunghezza totale, raccolti con una rete da spiaggia (chiamata migavica) tra luglio 1993 e giugno 1994. L'intensità alimentare è risultata alta durante tutto il periodo di studio ed è variata significativamente in relazione alle dimensioni degli esemplari. Nella dieta di* M. surmuletus *ha prevalso l'ordine Mysidacea. La composizione delle prede ingerite è variata con le dimensioni del predatore, pertanto i cefalopodi sono stati ritrovati esclusivamente nella dieta di esemplari di dimensioni maggiori a 185 mm. La dieta è variata stagionalmente. Gli anfipodi sono risultati il gruppo più importante di prede durante l'inverno e la primavera. I crostacei decapodi hanno predominato durante l'estate, mentre i misidiacei durante l'autunno. I risultati indicano che la triglia di scoglio si nutre di un limitato range di prede e può venir considerata uno specialista.*

Parole chiave: *Mullus surmuletus*, abitudini alimentari, ontogenesi, Adriatico centrale

INTRODUCTION

The study of the feeding habits of fish contributes to the knowledge of intra- and interspecific trophic relationships and thus leads to a better understanding of the structure and dynamics of marine communities. When commercially exploited species are involved as predators and/or as main prey species, the study of their feeding habits is a basic step for multispecies assessment approaches.

The striped red mullet is distributed along the eastern Atlantic from the English Channel to the northern part of West Africa and the Mediterranean Sea down to a depth of 400 m or more (Bauchot, 1987), inhabiting sand and soft substrates at depths of less than 100 m (Jardas, 1996).

The biology of the striped red mullet has not been studied extensively and only few papers deal exclusively with this species. N'Da (1992) and N'Da & Deniel (1993) studied its diet and sexual cycle, respectively, on the Brittany coast. Renones *et al.* (1995) examined its growth and reproduction off the island of Majorca. Despite its high commercial value, very little is known about the trophic ecology and behaviour of the striped red mullet. The literature on diet only points out that benthic invertebrates comprise the main dietary component (Gharbi & Ktari, 1979; Golani & Galil, 1991; N'Da, 1992; Golani, 1994). Labropoulou *et al.* (1997) pointed out that crustaceans predominated in the mullet's diet on the Cretan shelf and this species could be considered a specialist.

The main objective of this paper is to determine seasonal changes in trophic biology of the striped red mullet on a annual basis and to identify feeding trends of this species in the eastern central Adriatic.

MATERIALS AND METHODS

Samples were taken during four seasonal beach seine (called "migavica") survey cruises conducted by the Institute of Oceanography and Fisheries with the aid of professional fishermen in the area of the eastern central Adriatic (Šibenik area – Krapanj Island, Žaborić, Žirje Island; Split area – islands of Čiovo, Šolta, Mali Drvenik and Veli Drvenik) (Fig. 1). The cruise periods were as follows: 1 - July 1993, 2 - December 1993, 3 - April 1994, and 4 - June 1994.

A number of specimens (25-30) per area in each season were fixed immediately after capture in 8% buffered formalin for a subsequent stomach contents analysis. The specimens were taken to the laboratory, measured to the nearest mm (TL-total length) and weighed to the nearest 0.1 g. The stomachs were removed and the contents wet-weighed. Prey items were identified to the lowest possible taxonomic level, counted under a binocular microscope and weighed to the nearest 0.01 g.

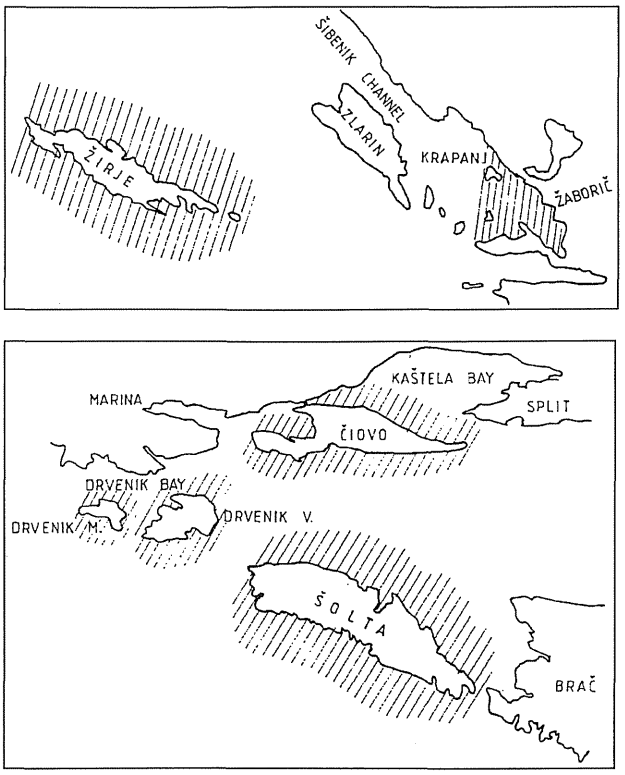


Fig. 1: Location of sampling stations in the eastern central Adriatic (Šibenik area - Krapanj Island, Žaborić, Žirje Island; Split area - Islands of Šolta, Čiovo, Mali Drvenik and Veli Drvenik).
Sl. 1: Lokacije vzorčišč v vzhodnem srednjem Jadranu (Šibeniško območje - otok Krapanj, Žaborić, otok Žirje; Splitsko območje - otoki Šolta, Čiovo, Mali Drvenik in Veli Drvenik).

Total length ranged from 58 to 250 mm (mean value = 134.7±33.6 mm). In order to evaluate size related variations in food habits, specimens were placed in 10 mm size classes as proposed by Labropoulou *et al.* (1997). The number of specimens per size class ranged between 25 and 66.

Numerous indices have been described for expressing the importance of different prey in the diets of fish quantitatively (Hyslop, 1980). Those used in the present study were:

- vacuity index (VI), *i.e.* number of empty stomachs divided by total number of stomachs multiplied by 100;
- percentage frequency of occurrence (F) based on the number of stomachs in which a food item was found, expressed as percentage of the total number of non-empty stomachs;
- percentage numerical abundance (C_n), *i.e.* the number of each prey item in all non-empty stomachs in a sample, expressed as percentage of the total number of food items in all stomachs in a sample;

- percentage gravimetric composition (C_w), *i.e.* the wet weight of each prey item, expressed as percentage of the total weight of the stomach contents in a sample.

The main food items were identified using the index of the relative importance (IRI) of Pinkas *et al.* (1971), as modified by Hacunda (1981):

$$IRI = (C_n + C_w) \times F$$

This index was expressed as %IRI = (IRI / ΣIRI) x 100. Prey were sorted in a decreasing order according to their percentage IRI contribution, and then cumulative %IRI was calculated. Cluster analysis employing Bray-Curtis similarity index (Field *et al.*, 1982) was performed on the standardised IRI values to describe ontogenetic and seasonal variations of food habits. Since all immature specimens smaller than 140 mm TL, corresponding to 55.7% of the total, could not be sexed, no attempt was made to detect dietary differences between sexes.

Niche breadth for the utilisation of food resources was calculated according to the Shannon-Wiener index (Krebs, 1989):

$$H' = \Sigma (p_i) (\ln p_i)$$

where p_i is the proportion of a specific prey category for the n categories of prey listed. Statistical differences in basic diet composition and stomach fullness as a function of size and season were established by applying a chi-squared test to the recorded values. One-way ANOVAs were used to compare the mean number and mean weight of prey items among the size classes and the a posteriori Tukey's test was employed to locate the source of any differences (Zar, 1984).

RESULTS

A total of 348 specimens were analysed. Of the total number of stomachs examined, 86 were empty (24.71%). The proportion of empty stomachs varied significantly among the size classes of fish examined ($P<0.001$), with the maximum of 49.88% for the largest fish (TL greater than 185 mm). Although empty stomachs were found throughout the year, the seasonal vacuity index did not differ significantly ($P>0.05$).

The diet of striped red mullet consisted of at least 66 different prey species belonging to five groups (Mysidacea, Amphipoda, Decapoda, fish, Polychaeta). The relative importance of the different prey groups with a contribution to the percentage IRI greater than 1 is given in Table 1. Mysidacea were the most important prey group, constituting 24.76% of the total IRI and made an important contribution to the diet (%IRI = 20.1), followed by amphipods (%IRI = 15.9), decapods (%IRI = 15.79) and fish (%IRI = 9.65). Among the decapods, Reptantia made an important contribution to the diet (%IRI = 8.73). The fact that the diet of the striped red mullet is dominated by few prey species is also supported by the low value of the Shannon-Wiener diversity index (H' = 0.88±0.04). Although the percentage IRI of the various prey groups varied with fish size, the chi-squared test revealed no significant difference ($P>0.05$) when the data for the large size classes were omitted. The «others» category included primarily cephalopods which occurred exclusively in the diet of large fish.

The total amount of food ingested, as shown by the mean weight of stomach contents, varied significantly among the size classes ($P<0.001$). No significant differences emerged among the size classes when the mean number of prey items per stomach was examined ($P>0.05$). However, the results have shown a tendency to increase the mean number of prey items towards larger size classes (differences not significant with Tukey's test). Dietary breadth increased with fish size for specimens larger than 170 mm TL, which indicates a tendency of more generalised feeding during later growth stages. Cluster analysis based on IRI values discriminated two main groups: fish with TL of 58-170 mm (group I, average similarity 85.0) and those with TL greater than 170 mm (group II, average similarity 80.9) (Fig. 2). However, the high similarity between the two groups discriminated by cluster analysis is indicative of slow and gradual changes in the diet composition with fish size.

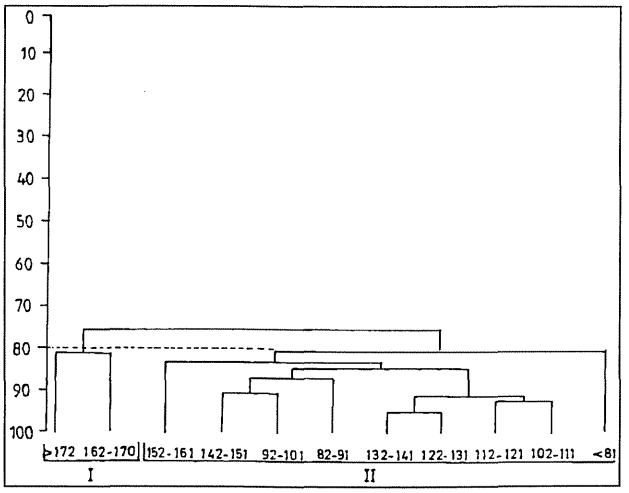


Fig. 2: Dendrogram of IRI values showing classification by* Mullus surmuletus *size into main groups.
Sl. 2: Dendrogram vrednosti IRI – razvrstitev progastih bradačev v glavne velikostne skupine.

Tab. 1: Percentage contribution of prey groups in** Mullus surmuletus **diet (C_n is percentage numerical composition; C_w is percentage gravimetric composition; F is frequency of occurrence; IRI is index of relative importance).
Tab. 1: Odstotni delež različnih skupin plena v prehrani progastega bradača** Mullus surmuletus **(C_n je odstotek numerične sestave; C_w je odstotek gravimetrične sestave; F je frekvenca pojavljanja; IRI je indeks relativne pomembnosti).

Prey category / *Kategorija plena*	C_n	C_w	F	IRI	%IRI
Crustacea					
Decapoda					
Natantia	2.40	4.60	39.90	279	4.08
Reptantia	4.80	9.80	40.90	597	8.73
Brachyura	1.50	3.80	38.50	204	2.98
Total / *Skupaj*	8.70	18.20	41.30	1080	15.79
Mysidacea	21.9	8.1	45.9	1377	20.1
Isopoda	10.3	9.3	23	452.4	6.6
Amphipoda	18.1	6.3	44.5	1086	15.9
Polychaeta	3.10	10.40	43.40	586	8.56
Bivalvia	2.1	0.1	37.3	82.1	1.2
Echinodermata	2.1	0.1	46.5	102	1.5
Teleostei					
Gobius sp.	0.9	1.5	39.3	94.3	1.38
Callionymus sp.	9.5	3.7	21.3	280.8	4.1
Pomatoschistus sp.	2.70	4.70	38.60	286	4.17
Total / *Skupaj*	13.10	9.90	99.2	661.1	9.65
Others / *Druge vrste plena*	2	6.2	15.7	129	1.9
No. of stomachs examined / *Št. pregledanih želodcev*	348				
No. of empty stomachs / *Št. praznih želodcev*	86				
Mean fish total length (mm) / *Srednja celotna dolžina rib (mm)*	134.7				
Mean stomach content weight (g) / *Srednja teža vsebine želodcev (g)*	0.52				
Mean number of prey items per stomach / *Srednje število lovnih vrst na želodec*	5.23				

The striped red mullet's feeding habit varied seasonally. Amphipods were the most important prey group in the winter (%IRI = 45) and spring (%IRI = 55.2). Decapod crustaceans predominated during the summer, while Mysidacea were predominant during the autumn. A chi-squared test revealed significant differences between the ingestion of Mysidacea ($\chi^2 = 9.6$, $P<0.05$) and amphipods ($\chi^2 = 8.3$, $P<0.05$), and also between the ingestion of amphipods and decapods ($\chi^2 = 7.1$, $P<0.05$). No significant seasonal differences were detected for other prey items. Diet breadth showed no significant overall effect of the seasons ($P>0.05$). Although seasonal influences were also examined as a function of fish size, no significant differences were found in size composition of the specimens throughout the year ($P>0.05$).

DISCUSSION

The presence of many common benthic and epibenthic organisms of appropriate size, such as mysids, decapods, polychaets and amphipods, further implies that the striped red mullet normally feeds on zoobenthos. This study indicates that the species relies almost exclusively on mysids, amphipods, decapods and fish, although eaten regularly were of minor importance. Other studies pointed out that crustacean decapods were major components in the striped red mullet's diet (Ben-Aliahu & Golani, 1990; Golani & Galil, 1991; Golani, 1994; Labropoulou *et al.*, 1997). This difference could be related to the probable differences in food availability between the areas involved. However, our results are not consistent with those of Gharbi & Ktari

(1979) and N'Da (1992) who reported that the striped red mullet's diet included a wider range of prey taxa with polychaets preferential. These differences may, in part, be due to the fact that in both studies dietary analysis was based on the frequency of occurrence and the numerical abundance of prey items, which are markedly influenced by small food items that may occur in high numbers but constitute of low biomass (Hall *et al.*, 1990). The availability and accessibility of prey are the factors that determine the importance of certain species in the diet of fishes. They could explain differences in diet at different times of the year and between different areas.

Most of the prey species found in the striped red mullet's diet usually live on sediment, while a few of them construct tubes in the sediment; they are normally open at both ends, and when feeding, may emerge completely or only partially from these tubes (Labropoulou *et al.*, 1997). No bottom sediment was found in the stomachs examined, which is in agreement with the findings of Labropoulou *et al.* (1997), so according to both studies it could be assumed that the striped red mullet consumes prey, which is active on the sediment surface, or selects individual infaunal prey items from the substrate.

The striped red mullet's diet is dominated by a relatively few items according to the recorded low value of the Shannon-Wiener diversity index in the present study, and the species could be considered a specialist. The striped red mullet, like all mullids, uses barbels to assist in foraging and prey capture (Ben-Eliahu & Golani, 1990), so it may be that the importance of the barbels in foraging behaviour has led to the restricted trophic diversity of this species, to small-size and slow-moving invertebrates that inhabit the soft sediments.

Relatively low values of the vacuity index throughout the sampling period indicate that the feeding intensity is high and that the seasons do not affect food intake, which is also evident from the study by Labropoulou *et al.* (1997). The high percentage of empty stomachs found in large size classes suggests that the feeding intensity is more pronounced in smaller specimens. Feeding intensity and frequency are directly correlated with meal size and digestion time. It is well known that for most demersal fish species there is a tendency for fish size to increase with depth, within their depth range. Juvenile stages occur in shallower, warmer waters, while older fish are found at greater, colder depths where they may benefit from lower metabolic cost and greater longevity. The high percentage of empty stomachs for the larger specimens may partially reflect an ontogenetic migration to the deeper waters, where temperature decreases significantly, which is in agreement with the observations and explanations made by Labropoulou *et al.* (1997). Many of the demersal fishes show a decrease in the feeding rate as the temperature drops (Tyler, 1971). Because of the reduced abundance of the prey and the lowered metabolism of the fish, predation on benthos was probably at a minimum during the winter. Environmental conditions are favourable during the warmer months and the food supply may be abundant enough to support the expanded fish community without competitive interactions. Trophic ontogeny in the striped red mullet could be also explained in terms of fish morphology. Ontogenetic changes in mouth size were expressed by relative mouth length (mouth length/total fish length) (Ross, 1978). Trophic ontogeny in the striped red mullet proceeds as a continuum of dietary changes rather than by distinct segregation of food resources between size classes (Labropoulou *et al.*, 1997). Golani & Galil (1991) pointed out that although larger fish are able to capture relatively larger prey, the morphological constraints such as the toothless upper jaw, the small mouth size and gape and the foraging behaviour impose certain limitations on the diet of this species and restrict their food to small benthic animals. Food specialisation and dietary breadth are a result of evolutionary development of unique feeding behaviour, morphology and mouth structure, which interact with the size, distribution and abundance characteristics of certain types of the available benthic fauna.

The observed seasonal changes in the relative importance of preferred prey probably reflect fluctuations of the available prey in the environment. Prey availability, however, is not only a function of its abundance in the habitat but also of its size, behaviour, density and relative abundance of the preferred prey items in the exploited habitats (Caragitsou & Papaconstantinou, 1988).

ACKNOWLEDGEMENTS

The author wishes to thank the Piveta brothers, professional fishermen from Okruk Donji (Čiovo Island), for providing him with the striped red mullet specimens. His thanks are also due to Kristina Brešković for her great help in preparing the specimens.

PREHRANA PROGASTEGA BRADAČA *MULLUS SURMULETUS* LINNAEUS, 1758 V VZHODNEM DELU SREDNJEGA JADRANA

Jakov DULČIĆ
Inštitut za oceanografijo in ribištvo, HR-21000 Split, Šetalište Ivana Meštrovića 63, p.p. 500
E-mail: dulcic@izor.hr

POVZETEK

Avtor je v vzhodnem delu srednjega Jadrana opravil raziskavo o prehrani progastega bradača Mullus surmuletus *Linnaeus, 1758, s posebnim ozirom na letne čase in velikost rib. Pregledana je bila vsebina želodcev osebkov, ki so bili ujeti s potegačo v obdobju med julijem 1993 in junijem 1994 in so merili od 58 do 250 mm (celotna dolžina). Intenziteta prehranjevanja je bila v času preiskave razmeroma visoka in je vključevala različne velikostne kategorije. Mizidni raki (Mysidacea) so bili prevladujoča kategorija plena. Sestava prehrane je bila odvisna od velikosti bradačev. Tako so se ribe in glavonožci pojavljali le v prehrani osebkov, večjih od 185 mm. Prehrana progastega bradača se je spreminjala z letnimi časi. Postranice (Amphipoda) so bile najpomembnejše pozimi in spomladi, raki deseteronožci (Decapoda) poleti, mizidni raki pa jeseni. Rezultati te preiskave kažejo, da se progasti bradač prehranjuje le z omejenimi vrstami plena, kar pomeni, da ga v tem pogledu lahko štejemo med specialiste.*

Ključne besede: progasti bradač, prehrana, ontogenija, vzhodni Jadran

REFERENCES

Bauchot, M. L. (1987): Mullidae. In: Fisher, W., Bauchot, M. L. & Schneider, M. (eds.): Fichees FAO d'identification des especes pour les besoins de la peche 37, vol. 2, Vertebres. FAO, Rome, 761-1530.

Ben-Eliahu, M. N. & D. Golani (1990): Polychaets (Annelida) in the gut contents of goatfishs (Mullidae), with new Polychaete records for the Mediterranean coast of Israel and the Gulf of Elat. P.S.Z.N.I. Marine Ecology, 11, 193-205.

Caragitsou, E. & C. Papaconstantinou (1988): Feeding habits of red pandora *(Pagellus erythrinus)* off the western coast of Greece. J. Appl. Ichthyol., 4, 14-22.

Field, J. G., K. R. Clark & R. M. Warwick (1982): A practical strategy for analysing multispecies distribution patterns. Mar. Ecol. Prog. Ser., 8, 37-52.

Gharbi, H. & M. H. Ktari (1979): Regime alimentaire des rougets *(Mullus barbatus* Linnaeus, 1758 et *Mullus surmuletus* Linnaeus, 1758) du Golfe de Tunis. Bulletin de l'Institut National Scientifique et Technique d'Oceanographie et de Peche Salammbo, 6, 41-52.

Golani, D. (1994): Niche separation between colonizing and indigenous goatfish (Mullidae) along the Mediterranean coast of Israel. J. Fish. Biol., 45, 503-513.

Golani, D. & B. Galil (1991): Trophic relationships of colonizing and indigenous goatfish (Mullidae) in the eastern Mediterranean with special emphasis on decapod crustaceans. Hydrobiologia, 218, 27-33.

Hacunda, J. S. (1981): Trophic relationships among demersal fishes in a coastal area of the Gulf of Main. Fisheries Bulletin, 79, 775-788.

Hall, S. J., D. Raffaelli, D. J. Basford, M. R. Robertson & R. Fryer (1990): The feeding relationships of the larger fish species in a Scottish sea loch. J. Fish. Biol., 37, 775-791.

Hyslop, E. J. (1980): Stomach contents analysis - a review of methods and their application. J. Fish. Biol., 17, 411-429.

Jardas, I. (1996): Jadranska ihtiofauna. Školska knjiga, Zagreb, 556 pp.

Krebs, C. J. (1989): Ecological Methodology. Harper and Row, New York, 654 pp.

Labropoulou, M., A. Machias, N. Tsimenidis & A. Eleftheriou (1997): Feeding habits and ontogenetic diet shift of the striped red mullet, *Mullus surmuletus* Linnaeus, 1758. Fish. Res., 31, 257-267.

N'Da, K. (1992): Regime alimentaire du rouget de roche *Mullus surmuletus* (Mullidae) dans le nord du Golfe de Gascogne. Cybium, 16, 159-167.

N'Da, K. & C. Deniel (1993): Sexual cycle and seasonal changes in the ovary of the red mullet, *Mullus surmuletus*, from the southern coast of Britany. J. Fish. Biol., 43, 229-244.

Pinkas, L., M. S. Olipham & I. L. K. Iversor (1971): Food habits of albacore, bluefin tuna and bonito in California waters. Fisheries Bulletin, 152, 1-105.

Ross, S. T. (1978): Trophic ontogeny of the leopard searobin, *Prinotus scitulus* (Pisces: Triglidae). Fisheries Bulletin, 76, 225-234.

Tyler, A. Y. (1971): Monthly changes in stomach contents of demersal fish in Passamaquoddy Bay. N.B. Fish. Res. Bd. Can. Techn. Paper, 288, 114 p.

Zar, J. H. (1984): Biostatistical Analysis. Prentice-Hall, Englewood Cliffs, 718 pp.

original scientific paper
received: 8. 1. 2002

UDC 597.3(262-11)

ELASMOBRANCH SPECIES OF THE SEAS OF TURKEY

Hakan KABASAKAL
Ichthyological Research Society, Atatürk mahallesi, Menteşoğlu caddesi,
İdil apt., No 30, D 4, TR-Ümraniye 81230 Istanbul
E-mail: hakankabasakal@hotmail.com

ABSTRACT

Field surveys and review of the available literature have revealed the presence of 69 elasmobranch species representing 21 families from the seas of Turkey. Ten of the 69 species are still questionable and require confirmation.

Key words: Seas of Turkey, elasmobranchs, distribution, species list

SPECIE DI ELASMOBRANCHI NEI MARI DELLA TURCHIA

SINTESI

Nell'articolo l'autore presenta una revisione dei dati di letteratura che, completa di nuove indagini sperimentali, rivela nei mari della Turchia la presenza di 69 specie di elasmobranchi appartenenti a 21 famiglie. Dieci delle 69 specie sono tuttora contestabili e richiedono conferma.

Parole chiave: mari della Turchia, elasmobranchi, distribuzione, lista delle specie

INTRODUCTION

The group of sharks, rays and skates is considered poorly known as far as the fish fauna of the Turkish seas is concerned. Cartilaginous fishes have not been commercially important in the Turkish sea fishery for a number of years, which is the reason why most of the ichthyological research has been focused on commercially important fish species. As a consequence of this circumstance, very limited data have been available concerning the elasmobranch species of the Turkish seas until the last two decades of the 20th century. During the mentioned period, elasmobranch species have been superficially researched only in general ichthyological studies (Akşıray, 1987; Devedjian, 1926; Erazi, 1942; Mater & Meriç, 1996). However, the recent drastic reduction in stocks of the traditional commercially important sea fishes means that chondrichthyan fishes are now considered new opportunities for sustaining the fisheries. Due to the highly increased catch of sharks and rays in Turkey within the last few years, a more thorough research into Chondrichthyan fauna in the seas of Turkey would be required. However, with the exception of some pioneering studies *(e.g.* Başusta *et al.*, 1998a, 1998b; Benli *et al.*, 1993; Kabasakal, 1995, 1998a, 1998b, 1998c; Kabasakal & Ünsal, 1999; Kutaygil & Bilecik, 1977, 1979; Okuş *et al.*, 1996; Uysal *et al*; 1996) no extensive investigations have been carried out on this subject so far.

The present paper aims to provide detailed information on the actual status of elasmobranch species occurring in the seas of Turkey.

MATERIAL AND METHODS

An extensive field survey was carried out between 1995 and 1999, and a total of 23 fishing ports along the Turkish coast were visited to collect or examine the specimens of elasmobranch species (Fig. 1). Whenever possible, the author joined to the fishermen (mostly otter-trawlers, purse-seiners, gill-netters and bottom- and pelagic-long liners) for collecting samples. Furthermore, the available literature of elasmobranchs of the Turkish seas was critically reviewed. In every case the following data were recorded: total length (TL) in cm, weight (W) in kg, and sex of the animal, date and location of capture. Whenever possible, individual specimens together with teeth and skin samples were collected. Formalin fixed specimens, including skin samples, were preserved at the Faculty of Fisheries of the University of Istanbul; jaws are preserved in the author's personal collection.

Identification of the species follows CLOFNAM (Whitehead *et al.*, 1984); taxonomic nomenclature follows the check-list proposed by the European Register of Marine Species:
(http://erms.biol.soton.ac.uk./lists/brief/Chondrichthyes.shtml).

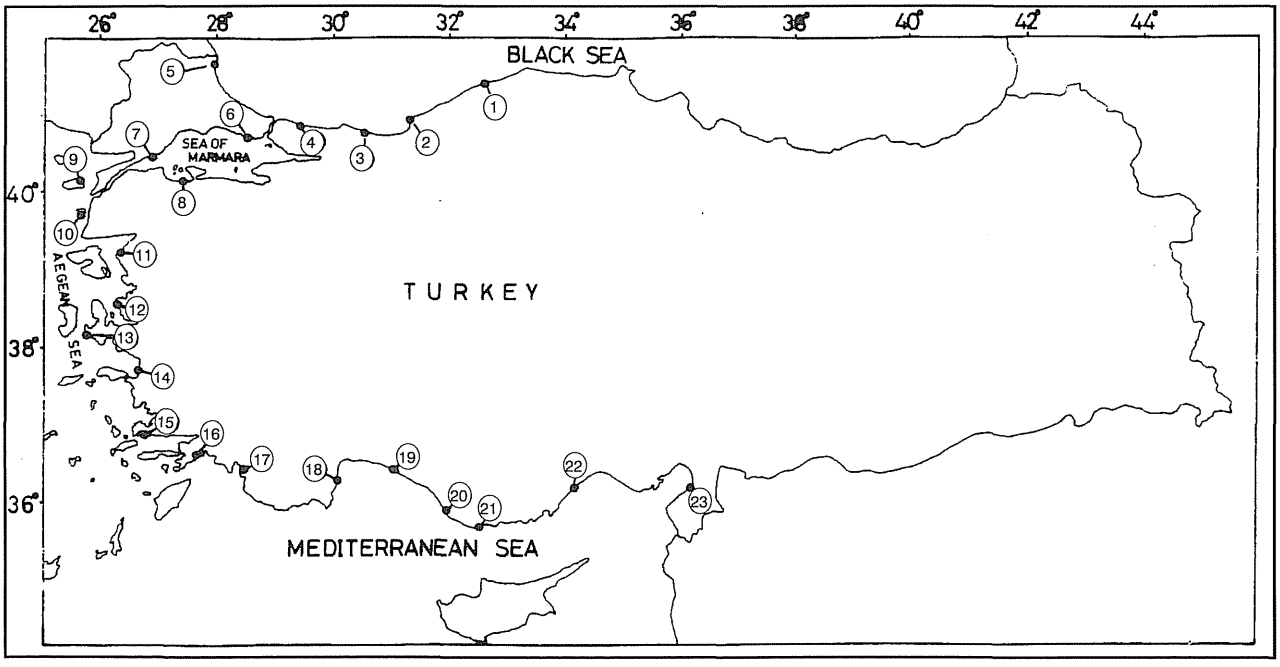


Fig. 1: Fishing ports visited during the field surveys along the coast of Turkey; names of the fishing ports are as follows: (1) Ereğli, (2) Akçakoca, (3) Karasu, (4) Şile, (5) Kıyıköy, (6) Küçükçekmece, (7) Şarköy, (8) Erdek, (9) Gökçeada, (10) Bozcaada, (11) Ayvalık, (12) Foça, (13) Çeşme, (14) Kuşadası, (15) Bodrum, (16) Marmaris, (17) Fethiye, (18) Kemer, (19) Manavgat, (20) Gazipaşa, (21) Anamur, (22) Erdemli, (23) İskenderun.
Sl. 1: Imena ribiških pristanišč vzdolž turške obale, obiskanih med terenskimi raziskavami.

For an easier understanding, actual status of elasmobranch species occurring in the seas of Turkey was classified under the following three categories: A) species examined in the present study; B) species cited by other researchers but not examined in the present study; and C) questionable species.

RESULTS AND DISCUSSION

Following the field surveys and the review of the available literature, a total of 69 elasmobranch species representing 21 families were recorded from the seas of Turkey. Forty-eight of the 69 species were captured during the present study, and these species, their examined numbers and sampling stations are listed in Table 1. Eleven of the remaining 21 species have been reported by other authors, while the last 10 elasmobranchs are represented by the species with a questionable occurrence in the area. Therefore, it should be understood that the total species number reported here is an estimated value and only 59 of them with a verified occurrence in the seas of Turkey. Classification of the actual status, zoogeographical characterisation and distribution in Turkish seas of this 69 species are summarised in Tables 2 and 3.

Zoogeographically, 34 (20.06%) of the 59 confirmed species are of Atlanto-Mediterranean origin, 19 (11.21%) are of cosmopolitan distribution, 4 (2.36%) of the Indo-Pacific origin are the so-called "Lessepsian" immigrants, and 2 (1.18%) are Mediterranean endemics. Before the present study, Akşıray (1987) recorded 59, Bauchot (1987) 50 and Mater & Meriç (1996) 53 elasmobranch species from the Turkish seas. These are the best literature on the chondrichthyan fauna of the seas of Turkey. Although these 10 questionable elasmobranchs, *Carcharias taurus*, *Carcharhinus limbatus*, *C. longimanus*, *C. obscurus*, *Sphyrna lewini*, *S. tudes*, *Echinorhinus brucus*, *Somniosus rostratus*, *Pristis pectinata* and *P. pristis*, have been recorded from the Turkish seas by Akşıray (1987) and Bauchot (1987), no information is available on these species in the most recent list of the Turkish sea fishes by Mater & Meriç (1996). However, with the exception of *C. longimanus*, *C. obscurus*, *Sphyrna lewini*, *P. pectinata* and *P. pristis*, the remaining questionable elasmobranchs *(C. taurus*, *C. limbatus*, *S. tudes*, *E. brucus* and *S. rostratus)* have been recorded from localities adjacent to Turkey by Ben-Tuvia (1971), Papaconstantinou (1988) and Papaconstantinou (1990). It could be assumed, therefore, that the species in the parenthesis may exist in the seas of Turkey. The former five sharks have only been reported by Akşıray (1987) without giving any information on the sampling location or where these species are kept for inspection.

All the 59 confirmed elasmobranch species are present in the Mediterranean and Aegean Seas, while only 27 of them have been recorded in the Sea of Marmara and 8 in the Black Sea. A clear decrease in the species number is observed from the Mediterranean to the Black Sea. Generally speaking, the main reason for this decrease lies in the interactions between the bio-ecological characteristics of chondrichthyans and the oceanographical peculiarities of the Turkish seas. After the opening of the Suez Channel in 1869, as well as due to the general heating of the world oceans, many extra-Mediterranean species have entered the area (the phenomenon known as the "tropicalisation" of the Mediterranean). In this context, the Mediterranean coast of Turkey has been subjected to a remarkable migration of Lessepsian fishes for many years (Gücü *et al.*, 1994). During the present study, the Lessepsian elasmobranchs, *Carcharhinus melanopterus*, *C. altimus*, *Himantura uarnak* and *Taeniura grabata*, have only been recorded along the eastern Mediterranean coast of Turkey (Başusta *et al.*, 1998a, 1998b).

The Aegean Sea is topographically divided into two basins by (approximately) the 38° parallel, *i.e.* into the North and South Aegean (Papaconstantinou, 1992). By taking in consideration the spreading of the Lessepsian immigrants, Papaconstantinou (1987) characterised the North Aegean Sea as an area of cold-water fauna and the South Aegean as the sea of warm-water fauna. Although a number of Lessepsian teleosts have been recorded from the South Aegean (Papaconstantinou, 1987), none of the mentioned Lessepsian elasmobranchs have been recorded in the same area. In comparison with the south part, the north Aegean Sea is characterised by the extended continental shelf and a constant annual water temperature range (13.5°C to 14°C) below 250 m (Papaconstantinou, 1992). Due to the steady environmental conditions and the presence of the considerable amount of juveniles and subadults of *Scyliorhinus canicula* below 200 m, D'Onghia *et al.* (1995) considered the bathyal grounds of the North Aegean Sea as an important spawning and nursery area of the lesser-spotted catshark. In the light of this result, catches of the otter-trawlers operated on the bathyal grounds of the mentioned area have been carefully examined, and not only the juveniles and subadults of *S. canicula*, but those of *Hexanchus griseus*, *Galeus melastomus*, *Etmopterus spinax*, *Dalatias licha*, *Centrophorus granulosus*, *C. uyato* and *Dipturus oxyrinchus*, and the holocephalan *Chimaera monstrosa* that have also been captured in the same area in considerable numbers. Therefore, the bathyal grounds of the North Aegean Sea could be considered as a breeding area for the mentioned species.

According to Öztürk & Öztürk (1996), the Sea of Marmara is an ecological barrier, a transition zone or an acclimatisation area, influencing the dispersal of the species between the Mediterranean and Black Seas. Twenty-five (92.59%) of the 27 recorded elasmobranchs from the Sea of Marmara are demersal fishes. The

Tab. 1: Elasmobranch species captured or examined during the field surveys.
Tab. 1: Morski psi in skati, ujeti ali pregledani med terenskimi raziskavami.

SPECIES	SPECIMENS	STATIONS
Hexanchus griseus (Bonnaterre, 1788)	(20)	6,7,9
Carcharodon carcharias (Linnaeus, 1758)	(2)	12,18
Isurus oxyrinchus Rafinesque, 1810	(5)	18,19,20
Cetorhinus maximus (Gunnerus, 1765)	(2)	19,23
Alopias vulpinus (Bonnaterre, 1788)	(3)	4,6,9,12,15,18,20
Galeus melastomus Rafinesque, 1810	(650)	6,7,9,10,13,14,16,23
Scyliorhinus canicula (Linnaeus, 1758)	(1200)	6,7,8,9,10,14,15,20,21,23
Scyliorhinus stellaris (Linnaeus, 1758)	(85)	8,9,10,11,13,15,19,20
Carcharhinus brevipinna (Müller & Henle, 1839)	(3)	14,16,23
Carcharhinus plumbeus (Nardo, 1827)	(2)	9,15,23
Prionace glauca (Linnaeus, 1758)	(6)	9,13,18,19,20
Galeorhinus galeus (Linnaeus, 1758)	(2)	9,17
Mustelus asterias Cloquet, 1821	(152)	6,7,9,11,17,18
Mustelus mustelus (Linnaeus, 1758)	(68)	6,7,8,9,10,11,12,21,22
Mustelus punctulatus Risso, 1827	(19)	9,10,17
Sphyrna zygaena (Linnaeus, 1758)	(3)	9,16
Etmopterus spinax (Linnaeus, 1758)	(97)	9,17
Oxynotus centrina (Linnaeus, 1758)	(6)	6,9,17
Dalatias licha (Bonnaterre, 1788)	(8)	6,9,17
Centrophorus granulosus (Bloch & Schneider, 1801)	(6)	6,9,18
Centrophorus uyato (Rafinesque, 1810)	(4)	6,7,15,16
Squalus acanthias Linnaeus, 1758	(540)	1,2,3,4,5,7,9,10,12,18,22
Squalus blainvillei (Risso, 1827)	(64)	3,4,9,10,17
Squatina aculeata Cuvier (ex Duméril), 1829	(1)	20
Squatina oculata Bonaparte, 1840	(3)	9,16,23
Squatina squatina (Linnaeus, 1758)	(51)	4,9,10,14,15,20,22
Rhinobatos rhinobatos (Linnaeus, 1758)	(4)	9,13,20,23
Torpedo (Tetronarce) nobiliana Bonaparte, 1835	(9)	7,9,10,12,18
Torpedo (Torpedo) marmorata Risso, 1810	(54)	7,9,10,11,20,23
Torpedo (Torpedo) torpedo (Linnaeus, 1758)	(2)	8,10,14,21
Dipturus batis (Linnaeus, 1758)	(9)	9,10,15,17
Dipturus oxyrinchus (Linnaeus, 1758)	(84)	6,9,14,20
Leucoraja naevus (Müller & Henle, 1841)	(9)	9,10
Raja asterias Delaroche, 1809	(65)	9,10,16
Raja clavata Linnaeus, 1758	(850)	1,2,3,4,5,6,7,8,9,10,14,18,22
Raja miraletus Linnaeus, 1758	(156)	9,10,15
Raja montagui Fowler, 1910	(6)	9,10,13,18
Raja polystigma Regan, 1923	(2)	10
Raja radula Delaroche, 1809	(96)	6,9,10,14,19
Raja undulata Lacepède, 1802	(3)	9,10,15
Rostroraja alba (Lacepède, 1803)	(2)	9,10
Dasyatis pastinaca (Linnaeus, 1758)	(175)	2,5,6,8,9,10,16,22
Dasyatis tortonesei Capapé, 1977	(6)	15,17
Gymnura altavela (Linnaeus, 1758)	(9)	9,23
Myliobatis aquila (Linnaeus, 1758)	(43)	8,9,10,15,18,19
Pteromylaeus bovinus (Geoffroy Saint-Hilaire, 1817)	(36)	9,10,15,20,22
Rhinoptera marginata (Geoffroy Saint-Hilaire, 1817)	(8)	9,14,23
Mobula mobular (Bonnaterre, 1788)	(2)	9,10,18,19

Tab. 2: List of the sharks recorded from the seas of Turkey up to date (list also includes the questionable species): (A) species examined during the present study; (B) species cited by other researchers but not examined during the present study; (C) questionable species; (*) denotes the presence and (–) the absence of species; (?) also denotes the questionable species; (+) previous recordings of the species; (Cos.) cosmopolitan; (Atl.M.) Atlanto-Mediterranean; and (Ind.P.) Indo-Pacific.

Tab. 2: Seznam morskih psov do zdaj ugotovljenih v turških morjih (vključuje tudi vprašljive vrste): (A) vrste, pregledane med pričujočo študijo; (B) vrste, ki jih navajajo drugi avtorji, a niso bile raziskane med pričujočo študijo; (C) vprašljive vrste; (*) označuje pojavljanje in (–) odsotnost vrst v območju; (?) ponazarja tudi vprašljive vrste; (+) prejšnji zapisi o vrstah; (Cos.) kozmopolitska vrsta; (Atl.M.) atlantsko-mediteranska vrsta; in (Ind.P.) indo-pacifiška vrsta.

SPECIES	MEDITERRANEAN SEA	AEGEAN SEA	SEA OF MARMARA	BLACK SEA	Devedjian, 1926	Erazi, 1942	Slastenenko, 1955-56	Akşıray, 1987	Bauchot, 1987	Benli *et al.*, 1993	Kocataş *et al.*, 1993	Meriç, 1995	Mater and Meriç, 1996	Okuş *et al.*, 1996	Uysal *et al.*, 1996	Kideyş, 1997 (in Başusta *et al.*, 1998a)	Başusta *et al.*, 1998a	Kabasakal, 1998a	Kabasakal, 1998b	Kabasakal & Ünsal, 1999	Classification & Zoogeographic Characterization
Heptranchias perlo	*	*	–	–				+	+												B/Cos.
Hexanchus griseus	*	*	*	–	+			+	+			+	+					+			AB/Cos.
Odontaspis ferox	*	*	–	–					+				+								B/Cos.
Carcharias taurus	?	?	–	–					+												C/Cos.
Carcharodon carcharias	*	*	?	–	+			+	+				+								AB/Cos.
Isurus oxyrinchus	*	*	–	–				+	+				+								AB/Cos.
Lamna nasus	*	*	*	–	+			+	+				+								B/Cos.
Cetorhinus maximus	*	*	–	–				+	+				+			+					AB/Cos.
Alopias vulpinus	*	*	*	*	+	+		+	+		+		+						+		AB/Cos.
Galeus melastomus	*	*	*	–				+	+		+	+	+		+						AB/Atl.M.
Scyliorhinus canicula	*	*	*	*	+	+	+	+	+		+	+	+	+			+				AB/Atl.M.
Scyliorhinus stellaris	*	*	*	–				+	+		+	+	+								AB/Atl.M.
Carcharhinus brevipinna	*	*	–	–				+	+				+								AB/Cos.
Carcharhinus melanopterus	*	–	–	–				+	+				+								B/Ind.P.
Carcharhinus plumbeus	*	*	–	–				+	+				+				+				AB/Cos.
Carcharhinus altimus	*	–	–	–													+				B/Ind.P.
Carcharhinus limbatus	?	–	–	–					+												C/Cos.
Carcharhinus longimanus	?	–	–	–				+													C/Cos.
Carcharhinus obscurus	?	–	–	–				+													C/Cos.
Prionace glauca	*	*	–	–	+			+	+				+								AB/Cos.
Galeorhinus galeus	*	*	–	–				+	+				+								AB/Cos.
Mustelus asterias	*	*	*	–				+	+			+	+								ABAtl.M.
Mustelus mustelus	*	*	*	–	+	+		+	+		+	+	+	+			+				AB/Atl.M
Mustelus punctulatus	*	*	–	–				+	+				+								ABAtl.M.
Sphyrna lewini	?	–	–	–				+													C/Cos.
Sphyrna tudes	?	–	–	–				+													C/Atl.M.
Sphyrna zygaena	*	*	–	–				+	+				+								AB/Cos.
Echinorhinus brucus	?	?	–	–				+	+												C/Cos.
Etmopterus spinax	*	*	–	–				+	+				+							+	AB/Atl.M.
Somniosus rostratus	?	?	–	–				+													C/Atl.M.
Oxynotus centrina	*	*	*	–		+		+	+				+				+				AB/Atl.M.
Dalatias licha	*	*	*	–				+	+			+									AB/Cos.
Centrophorus granulosus	*	*	*	–				+	+	+		+	+								AB/Atl.M.
Centrophorus uyato	*	*	*	–				+				+									AB/Atl.M.
Squalus acanthias	*	*	*	*	+	+	+	+	+		+	+	+								AB/Cos.
Squalus blainvillei	*	*	*	*		+	+	+	+		+	+	+	+							AB/Cos.
Squatina aculeata	*	–	–	–																	A/Atl.M.
Squatina oculata	*	*	–	–				+	+				+								AB/Atl.M.
Squatina squatina	*	*	*	*	+	+		+	+		+		+								AB/Atl.M.

Tab. 3: List of rays and skates recorded in the seas of Turkey up to date (list also includes the questionable species): A) species examined in the present study; (B) species cited by other researchers but not examined in the present study; (C) questionable species; (✶) denotes the presence and (–) the absence of species; (?) also denotes the questionable species; (+) previous recordings of the species; (Cos.) cosmopolitan; (Atl.M.) Atlanto-Mediterranean; and (Ind.P.) Indo-Pacific.

Tab. 3: Seznam skatov do zdaj ugotovljenih v turških morjih (vključuje tudi vprašljive vrste): (A) vrste, pregledane med pričujočo študijo; (B) vrste, ki jih navajajo drugi avtorji, a niso bile raziskane med pričujočo študijo; (C) vprašljive vrste; (✶) označuje pojavljanje in (–) odsotnost vrst v območju; (?) ponazarja tudi vprašljive vrste; (+) prejšnji zapisi o vrstah; (Cos.) kozmopolitska vrsta; (Atl.M.) atlantsko-mediteranska vrsta; in (Ind.P.) indo-pacifiška vrsta.

SPECIES	MEDITERRANEAN SEA	AEGEAN SEA	SEA OF MARMARA	BLACK SEA	Devedjian, 1926	Erazi, 1942	Slastenenko, 1955-56	Kutaygil & Bilecik, 1979	Akşıray, 1987	Bauchot, 1987	Kocataş *et al.*, 1993	Kabasakal, 1995	Mater & Meriç, 1996	Okuş *et al.*, 1996	Uysal *et al.*, 1996	Başusta *et al.*, 1998a	Başusta *et al.*, 1998b	Kabasakal, 1998c	Classification & Zoogeographic Characterization
Pristis pectinata	?	–	–	–					+										C/Atl.M.
Pristis pristis	?	–	–	–					+										C/Atl.M.
Rhinobatos cemiculus	✶	✶	–	–					+	+			+						B/Atl.M.
Rhinobatos rhinobatos	✶	✶	–	–					+	+			+			+			AB/Atl.M.
Torpedo (Tetronarce) nobiliana	✶	✶	✶	–						+			+			+			AB/Atl.M.
Torpedo (Torpedo) marmorata	✶	✶	✶	–	+					+			+			+			AB/Atl.M.
Torpedo (Torpedo) torpedo	✶	✶	✶	–						+			+						AB/Atl.M.
Dipturus batis	✶	✶	–	–	+								+						AB/Atl.M.
Dipturus oxyrinchus	✶	✶	✶	–						+	+		+		+				AB
Leucoraja fullonica	–	✶	–	–									+						B/Atl.M.
Leucoraja naevus	✶	✶	–	–						+			+		+				AB/Atl.M.
Raja asterias	✶	✶	✶	–						+			+			+			AB/Atl.M.
Raja clavata	✶	✶	✶	✶	+	+	+	+		+	+	+	+	+		+			AB/Cos.
Raja miraletus	✶	✶	✶	–						+			+			+			AB/Cos.
Raja montagui	✶	✶	✶	–									+						AB/Atl.M.
Raja polystigma	–	✶	–	–									+					+	AB/E.
Raja radula	✶	✶	✶	–						+		+	+			+			AB/Atl.M.
Raja undulata	✶	✶	–	–						+			+						AB/Atl.M.
Rostroraja alba	–	✶	–	–									+						AB/Atl.M.
Dasyatis centroura	✶	✶	–	–						+			+			+			B/Atl.M.
Dasyatis pastinaca	✶	✶	✶	✶		+	+			+	+		+	+		+			AB/Atl.M.
Dasyatis tortonesei	✶	✶	–	–									+						AB/E.
Dasyatis violacea	–	✶	–	–									+						B/Cos.
Himantura uarnak	✶	–	–	–									+				+		B/Ind.P.
Taeniura grabata	✶	–	–	–												+	+		B/Ind.P.
Gymnura altavela	✶	✶	✶	✶						+			+			+			AB/Atl.M.
Myliobatis aquila	✶	✶	✶	–	+	+				+	+		+	+					AB/Atl.M.
Pteromylaeus bovinus	✶	✶	–	–						+			+			+			AB/Atl.M.
Rhinoptera marginata	✶	✶	–	–						+			+			+			AB/Atl.M.
Mobula mobular	✶	✶	–	–						+			+						AB/Atl.M.

presence of pelagic sharks in this sea has always been considered a point of discussion. The earliest records of pelagic sharks from the Sea of Marmara have been reported by Devedjian (1926). He stated that *Carcharodon carcharias* (= *Carcharodon Rondeletii* in Devedjian), *Lamna nasus* (= *Lamna cornubica)* and *Alopias vulpinus* (= *Alopias vulpes*) occurred in the Sea of Marmara and that these sharks seldom landed at the Istanbul Fish Market as by-catches. Among these pelagic sharks, occurrence of *Alopias vulpinus* in the Sea of Marmara has been well documented (Erazi, 1942; Kocataş *et al.*, 1993), as well as a juvenile male thresher shark (190 cm TL) caught in this sea on April 12th 1997 and examined during the present study. On the other hand, *Lamna nasus* has been recorded in the Sea of Marmara by Akşıray (1987), Bauchot (1987) and Mater & Meriç (1996), although the most recent record of the porbeagle shark is probably based on the former two recordings. Furthermore, no specimens of this shark was captured during the present study. Devedjian (1926) recorded the great white shark in the Sea of Marmara, and more recently, Fergusson (1996) reported 3 records of the great white shark in the Bosporus. Further research is therefore required for confirm the presence of Lamnoid sharks in this sea.

The Black Sea has a very poor chondrichthyan fauna and only 8 species were recorded during the present study. Pelagic sharks, following the schools of pelagic teleosts, rarely enter the Black Sea (Kabasakal, 1998b). The high hydrogen sulphide concentration prevailing below 150 to 200 m in the Black Sea is an important factor preventing the dispersal of fishes in the deep zones of this sea (Kutaygil & Bilecik, 1976). In the Sea of Marmara, some of the elasmobranch species, *H. griseus, G. melastomus, C. granulosus, C. uyato, D. licha, O. centrina* and *Isurus oxyrinchus,* have also been recorded on bathyal grounds (Benli *et al.*, 1993; Meriç, 1995; Uysal *et al.*, 1996; Kabasakal, 1998a). Due to above reason, it is very clear that in the Black Sea a similar bathymetric distribution of fishes is not possible.

Although the present study presents the most extensive research on shark and ray species from the seas of Turkey up to date, the list given here is far from complete, but it is hoped that it may soon increase with new records of elasmobranchs occurring in the Turkish seas.

ACKNOWLEDGEMENTS

The author wishes to thank all the fishermen for their help during the field surveys.

MORSKI PSI IN SKATI (ELASMOBRANCHII) TURŠKIH MORIJ

Hakan KABASAKAL
Ichthyological Research Society, Atatürk mahallesi, Menteşoğlu caddesi,
İdil apt., No 30, D 4, TR-Ümraniye 81230 Istanbul
E-mail: hakankabasakal@hotmail.com

POVZETEK

Pričujoča študija je bila izdelana z namenom zagotoviti nove podatke o trenutnem statusu morskih psov in skatov, pojavljajočih se v turških morjih. Avtor je med letoma 1995 in 1999 obiskal 23 ribiških pristanišč vzdolž turške obale, da bi zbral ali preučil ujete primerke iz podrazreda Elasmobranchii. S terenskimi raziskavami in pregledom obstajajoče literature je ugotovil, da v turških morjih živi ali se pojavlja 69 vrst morskih psov in skatov iz 21 različnih družin. Deset od 69 vrst je še vedno vprašljivih in jih je treba še potrditi. Zoogeografsko je 34 (20,06%) od 59 potrjenih vrst atlantsko-mediteranskega, 19 (11,21%) kozmopolitskega in 4 (2,36%) indo-pacifiškega izvora, medtem ko sta 2 vrsti (1,8%) mediteranska endemita. Vseh 59 potrjenih vrst se pojavlja v Sredozemskem in Egejskem morju, 27 vrst v Marmarskem in 8 v Črnem morju.

Ključne besede: turška morja, hrustančnice, razširjenost, popis vrst

REFERENCES

Akşıray, F. (1987): Türkiye Deniz Balıkları ve Tayin Anahtarı. 2nd Edition, Publications of Istanbul University, no. 3490, Istanbul, 811 pp.

Başusta, N., Ü. Erdem & C. Çevik (1998a): An investigation on chondrichthyes in Iskenderun Bay. Celal Bayar University, Journal of Science and Arts Faculty, The Series of Natural Sciences (Biology), 1, 63-69.

Başusta, N., Ü. Erdem & M. Kumlu (1998b): Two new fish records for the Turkish seas: Round stingray *Taeniura grabata* and skate stingray *Himantura uarnak* (Dasyatidae). Israel Journal of Zoology, 44, 65-66.

Bauchot, M.-L. (1987): Requins. In: W. Fischer, M. Schneider, & M.-L. Bauchot (Eds.) Fiches FAO d'identification des espèces pour les besoins de la pêche. (Révision 1). Méditerranée et mer Noire. Zone de pêche 37. Vol. II. Vertebres. FAO, Roma, 767-843.

Benli, H. A., B. Cihangir & K. C. Bizsel (1993): A new record for the Sea of Marmara; (Family: Squalidae) *Centrophorus granulosus* (Bloch & Schneider, 1801). Tr. J. of Zoology, 17(2), 133-135.

Ben-Tuvia, A. (1971): Revised list of the Mediterranean fishes of Israel. Israel Journal of Zoology, 20, 1-39.

Devedjian, K. (1926): Pêche et Pêcheries en Turquie. Imprimerie de L'Administration de la Dette Publique Ottomane, Istanbul, 480 pp.

D'Onghia, G., A. Matarrese, A. Tursi & L. Sion (1995): Observations on the depth distribution pattern of the small-spotted catshark in the North Aegean Sea. Journal of Fish Biology, 47, 421-426.

Erazi, R. A. R. (1942): Marine fishes found in the sea of Marmara and in the Bosphorus. Revue de la Faculté des Sciences de l'Université d'Istanbul, B, 7(1/2), 103-115.

Fergusson, I. K. (1996): Distribution and autecology of the white shark in the eastern North Atlantic Ocean and the Mediterranean Sea. In Klimley, A. P. & D. G. Ainley (eds.): Great white sharks: The biology of *Carcharodon carcharias*. San Diego, Academic Press, 321-345.

Gücü, A. C., F. Bingel, D. Avşar & N. Uysal (1994): Distribution and occurrence of Red Sea fish at the Turkish Mediterranean coast-northern Cilician basin. Acta Adriatica, 34(1/2), 103-113.

Kabasakal, H. (1995): A research on determination and distribution of the skates (Rajidae) in the Bosphorus Strait and the western part of the Turkish Black Sea. Master Thesis, University of Istanbul, 46 pp.

Kabasakal, H. (1998a): The first record of the bluntnose six-gill shark [*Hexanchus griseus* (BONNATERRE, 1788)] in the Sea of Marmara. Acta Adriatica, 39(1), 67-70.

Kabasakal, H. (1998b): A note on the occurrence of the thresher shark, *Alopias vulpinus* from south-western Black Sea. J. Mar. Biol. Ass. U.K., 78, 685-686.

Kabasakal, H. (1998c): The first record of the speckled ray, *Raja (Raja) polystigma* REGAN, 1923 in the Seas of Turkey. Acta Adriatica, 39(1), 61-66.

Kabasakal, H. & N. Ünsal (1999): Observations on *Etmopterus spinax* (Pisces: Squalidae) from the north-eastern Aegean Sea. Bilješke-Notes, 81, 12 pp.

Kıdeyş, A. E. (1997): Occurrence of the basking shark, *Cetorhinus maximus* in the northern Levantine, the eastern Mediterranean. The International Mediterranean Fisheries Congress, University of Ege, Faculty of Fisheries, Izmir, Book of Abstracts, p. 120.

Kocataş, A., T. Koray, M. Kaya & Ö. F. Kara (1993): Review of the fishery resources and their environment in the Sea of Marmara. Studies and Reviews, General Fisheries Council for the Mediterranean, 64, Fisheries and Environmental Studies in the Black Sea. FAO, Roma, 87-143.

Kutaygil, N. & N. Bilecik (1976): Observations sur les principaux produits démersaux qui sont pêchés sur les côtes Turques de la mer Noire. Rapp. Comm. int. Mer Médit., 23(8), 75-77.

Kutaygil, N. & N. Bilecik (1977): Recherches sur les *Squalus acanthias* L. du littoral Anatolien de la mer Noire. Rapp. Comm. int. Mer Médit., 24(5), 81-83.

Kutaygil, N. & N. Bilecik (1979): La distribution du *Raja clavata* L. sur le littoral anatolien de la mer Noire. Rapp. Comm. int. Mer Médit., 25/26(10), 95-98.

Mater, S. & N. Meriç (1996): Deniz Balıkları. In: Kence, A. & Bilgin, C. C. (Eds.). Türkiye Omurgalılar Tür Listesi, TÜBİTAK, Ankara, 183 pp.

Meriç, N. (1995): A study on existence of some fishes on the continental slope of the Sea of Marmara. Tr. J. of Zoology, 19(2), 191-198.

Okuş, E., A. Uysal & A. Yüksek (1996): Marmara Denizinde köpekbalığı dağılımı. XIII. Ulusal Biyoloji Kongresi, September 17-20, 1996, University of Istanbul, Faculty of Sciences, Istanbul, Book of Abstracts, p. 31.

Öztürk, B. & A. A. Öztürk (1996): On the biology of the Turkish straits system. Bull. Inst. océanogr, Monaco, n° spécial 17, 205-221.

Papaconstantinou, C. (1987): Distribution of the Lessepsian fish migrants in the Aegean Sea. Biologia Gallohellenica, 13, 15-20.

Papaconstantinou, C. (1988): Check-list of marine fishes of Greece. National Center for Marine Research & Hellenic Zoological Society (Ed.), Athens, 257 pp.

Papaconstantinou, C. (1990): Some rare mesopelagic and bathyal fish caught in the Greek seas. Thalassographica, 13, 35-39.

Papaconstantinou, C. (1992): General remarks on the Greek seas fish fauna. Doriana, 6(274), 8 pp.

Slastenenko, E. (1955-56): The fishes of the Black Sea basin. Et ve Balık Kurumu Umum. Müd. Yayınları, Istanbul, 711 pp.

Uysal, A., A. Yüksek & E. Okuş (1996): Marmara Denizi'nde ender rastlanan üç elasmobranchii türü ve dağılımları *(Raja naevus* Müller & Henle, 1841; *Raja oxyrinchus* Linnaeus, 1758; *Galeus melastomus* Rafinesque, 1809). XIII. Ulusal Biyoloji Kongresi, September 17-20, 1996, University of Istanbul, Faculty of Sciences, Istanbul, Book of Abstracts, p. 28.

Whitehead, P. J. P., M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (Eds.) (1984): Fishes of the North-eastern Atlantic and the Mediterranean. Vol. I, UNESCO, Paris, 510 pp.

original scientific paper
received: 25. 3. 2002

UDC 597(262)

PRESENCE OF ATYPICAL CHARACTERISTICS IN A SPECIMEN OF SMALL-SPOTTED CATSHARK *SCYLIORHINUS CANICULA* (LINNAEUS, 1758) CAUGHT IN THE MEDITERRANEAN

Joan BARRULL, Isabel MATE & Manel BUENO
Lab. Vertebrats, Secció Ictiologia, Museu Zoologia (Museu Ciències Naturals)
Ap. Correus 593, E-08080 Barcelona
E-mail: jbarrull@pie.xtec.es
isabelmate@hotmail.com
manelbueno@correu.vilaweb.com

ABSTRACT

Authors describe some morphological deformities of first dorsal and caudal fins in an specimen of a small-spotted catshark, Scyliorhinus canicula, *caught on December 1st 2000 in Catalan waters (NW Mediterranean), and discuss its biological efficiency.*

Key words: *Scyliorhinus canicula,* atypical characteristics, dorsal fin, caudal fin, Mediterranean Sea

PRESENZA DI CARATTERI ATIPICI IN UN ESEMPLARE DI GATTUCCIO MINORE *SCYLIORHINUS CANICULA* (LINNAEUS, 1758) IN ACQUE MEDITERRANEE

SINTESI

Gli autori descrivono alcune deformità morfologiche della prima pinna dorsale e della pinna caudale di un esemplare di gattuccio minore, Scyliorhinus canicula, *pescato II Dicembre 2000 in acque Catalane (Mediterraneo Nord-Occidentale), e discutono circa l'efficienza biologica dell'individuo.*

Parole chiave: *Scyliorhinus canicula,* caratteri atipici, pinna dorsale, pinna caudale, Mare Mediterraneo

INTRODUCTION

Small-spotted catshark *Scyliorhinus canicula* (Linnaeus, 1758) is an abundant temperate bottom-dwelling catshark of the Eastern North Atlantic, from Norway and British Isles to the Mediterranean and Senegal (Compagno, 1984b).

In the Mediterranean Sea, these sharks are found on soft grounds of sand or mud from shore to depths of about 560 m (Capapé, 1974; Bini, 1967; Lloris, 1977; Allué, 1985; D'Onghia *et al.*, 1995; Barrull *et al.*, 1999). They are usually caught by trawlers (Barrull & Mate, 1996).

The current study of the ecology of the small-spotted catshark has allowed us to observe more than 1500 specimens, males and females, young and adults. In one of them several morphological abnormalities were discovered.

Morphological, anatomical, and colouring abnormalities are relatively rare in sharks. The ichthyological literature refers to some cases from different marine regions and cited by various authors, such as Punnet (1901, 1902), Lozano Cabo (1945), Arthur (1950), Menon (1957), Cadenat (1960), Fuller (1961), Clark (1964), Bensam (1965), Barkhshi & Saxena (1966), King (1966), McKenzie (1970), Abe (1972), Nakaya (1973), Capapé & Zahnd (1974), Capapé & Pantoustier (1975), Quero (1978), Capapé *et al.* (1979), Taniuchi & Yanagisawa (1987), and Heupel *et al.* (1999). In this report we discuss the capture of a small-spotted catshark *Scyliorhinus canicula* in the waters of the Catalan Sea. Some abnormalities in the first dorsal fin and in caudal fin were noted in this particular specimen.

MATERIAL AND METHODS

A female small-spotted catshark *Scyliorhinus canicula* (Linnaeus, 1758) (Fig. 1) was caught in Catalonia's continental slope waters on December 1st 2000 by "Maireta II", a fishing vessel based in the port of Barcelona (Spain). The specimen was caught with a trawler net, at a depth of 200 m, on the fishing ground know as "La Serola", at a geographical position of 41° 15′ N - 2° 23′ E and 41° 11′ N – 2° 20′ E. The specimen was identified according to Compagno (1984b). The morphometric measurements were made following Compagno (1984a). It was preserved in 70% ethyl alcohol and deposited in the Ichthyological Collection of the Zoology Museum of Barcelona, with catalogue number MZB-2000-1312. The small-spotted catshark was examined for parasites. Stomach was dissected and the contents identified. The reproductive tract was examined to determine maturity according to Moreno & Hoyos (1982).

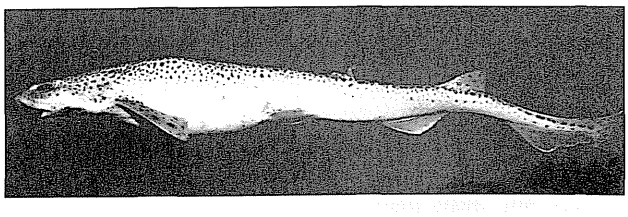


Fig. 1: Small-spotted catshark *Scyliorhinus canicula*, ***caught on December 1st 2000 in coastal waters off Barcelona. (Photo: J. Barrull & I. Mate)***
Sl. 1: Mala morska mačka *Scyliorhinus canicula*, ***ujeta 1. decembra 2000 v obrežnih vodah nedaleč od Barcelone. (Foto: J. Barrull & I. Mate)***

Tab. 1: Proportional dimensions (% TOT) of small-spotted catshark, *Scyliorhinus canicula*, ***caught off Barcelona.***
Tab. 1: Proporcionalne mere (% celotne iztegnjene dolžine) male morske mačke *Scyliorhinus canicula*, ***ujete v bližini Barcelone.***

		MZB-2000-1312
SEX		**F**
TOTAL LENGTH (mm)	**TOT**	**435**
PRECAUDAL LENGTH	**PRC**	78.6
PRE-FIRST DORSAL LENGTH	**PD1**	50.6
PRE-SECOND DORSAL LENGTH	**PD2**	67.6
FIRST DORSAL LENGTH	**D1L**	7.1
SECOND DORSAL LENGTH	**D2L**	4.4
FIRST DORSAL BASE	**D1B**	4.4
SECOND DORSAL BASE	**D2B**	4.4
FIRST DORSAL INNER MARGIN	**D1I**	-
SECOND DORSAL INNER MARGIN	**D2I**	2.7
FIRST DORSAL HEIGHT	**D1H**	-
SECOND DORSAL HEIGHT	**D2H**	3.2
DORSAL CAUDAL MARGIN	**CDM**	21.4
PREVENTRAL CAUDAL MARGIN	**CPV**	7.8
TERMINAL CAUDAL LOBE	**CTL**	7.6
PREPECTORAL LENGTH	**PP1**	16.1
PECTORAL ANTERIOR MARGIN	**P1A**	14.0
PECTORAL POSTERIOR MARGIN	**P1P**	9.2
PECTORAL BASE	**P1B**	4.6
PECTORAL INNER MARGIN	**P1I**	6.9
PREPELVIC LENGTH	**PP2**	40.2
PELVIC LENGTH	**P2L**	11.3
PELVIC ANTERIOR MARGIN	**P2A**	5.7
PREANAL LENGTH	**PAL**	59.8
ANAL LENGTH	**ANL**	14.0
ANAL BASE	**ANB**	12.2
ANAL INNER MARGIN	**ANI**	1.8
ANAL HEIGHT	**ANH**	3.2
MOUTH WIDTH	**MOW**	7.1
PREORAL LENGTH	**POR**	3.9
NOSTRIL WIDTH	**NOW**	1.6
INTERNARIAL SPACE	**INW**	4.4
PRENARIAL LENGTH	**PRN**	4.4
PRESPIRACULAR LENGTH	**PSP**	8.5
PREORBITAL LENGTH	**POB**	4.6
EYE LENGTH	**EYL**	3.4
EYE HEIGHT	**EYH**	1.8
INTERGILL LENGTH	**ING**	6.0
FIRST GILL SLIT HEIGHT	**GS1**	2.7
FIFTH GILL SLIT HEIGHT	**GS5**	1.1

RESULTS AND DISCUSSION

The female small-spotted catshark *Scyliorhinus canicula* measured 435 mm in total length and weighed 292 g. The main morphometric data of the specimen are presented in Table 1. The female was an adult, with intense vitellogenesis, the ovary containing a clutch of maturing

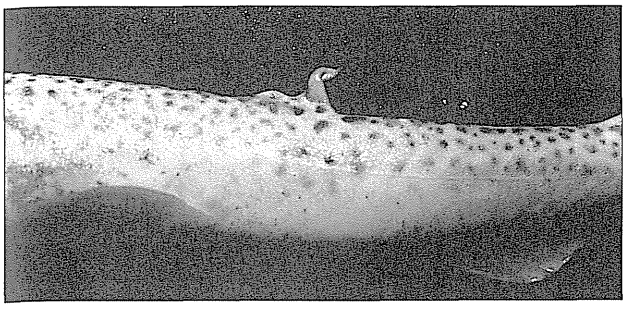


Fig. 2: Detail of the catshark's deformed first dorsal fin. (Photo: J. Barrull & I. Mate)
Sl 2: Detajl mačkine deformirane prve hrbtne plavuti. (Foto: J. Barrull & I. Mate)

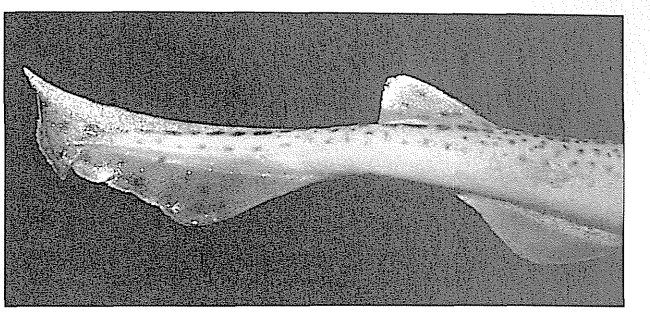


Fig. 3: Detail of the deformed caudal lobe. (Photo: J. Barrull & I. Mate)
Sl. 3: Detajl mačkine deformirane repne krpice. (Foto: J. Barrull & I. Mate)

oocytes. No external parasites were found. Internal stomach parasitic nematodes of species *Proleptus obtusus* Dujardin,1845 were found. The examination of the stomach content revealed only fragments of bony fish.

Its body marks and diagnostic features presented no particular differences from that observed in other adults of this species, except for the first dorsal (Fig. 2) and caudal fins (Fig. 3).

The first dorsal fin was only a vestige and the terminal lobe of the caudal fin was not differentiated. The authors considered the possibility that these abnormalities could be due to genetic mutation, or because of a bite made by a congener or some other predator. After a detailed examination of both fins it seemed there were marks of shark bites similar to those found in other works (López *et al.*, 1996). Therefore, the abnormalities could be a result of a genetic factor.

It is possible that these abnormalities could decrease the biological efficiency of the animal due to the absence of the two important elements for its self-propulsion and stability. However, the examination of the digestive and reproductive tracts seemed to confirm that the characteristics described about the first dorsal fin and the tail have not deprived the animal to achieve a considerable size and sexual maturity. Probably, the second dorsal fin with a regular dimension and placed near the caudal fin acted as a substitutive stabilising element. Moreover, this second dorsal fin and the lower caudal lobe acted as propellers to the preys capture and so let the animal grow normally as indicated by the necropsy.

The abnormalities in sharks are relatively rare. We have detected very few cases of malformations after examining thousands of individuals of different species all over the Catalan Sea.

Although these differences have, *a priori*, a limited interest for the biological and systematic knowledge of the species, they can offer some additional genetic and embryological data, and about the individuals' biological efficiency.

ACKNOWLEDGEMENTS

We wish to thank Mr. David Albiol and the "Maireta II" crew for their help in collecting sharks. Special thanks are due to Dr. Christian Capapé who was especially helpful in providing information and articles. We would also like to thank Dr. Alessandro De Maddalena for translating the abstract into Italian.

POSEBNOSTI, UGOTOVLJENE PRI MALI MORSKI MAČKI *SCYLIORHINUS CANICULA* (LINNAEUS, 1758), UJETI V SREDOZEMSKEM MORJU

Joan BARRULL, Isabel MATE & Manel BUENO
Lab. Vertebrats, Secció Ictiologia, Museu Zoologia (Museu Ciències Naturals)
Ap. Correus 593, E-08080 Barcelona
E-mail: jbarrull@pie.xtec.es; isabelmate@hotmail.com; manelbueno@correu.vilaweb.com

POVZETEK

Mala morska mačka Scyliorhinus canicula *(Linnaeus, 1758) je pogosta prebivalka pridnenih zmerno toplih voda v vzhodnem Severnem Atlantiku. Dne 1. decembra 2000 je bila samica te vrste ujeta z vlečno mrežo v globini 200 metrov v vodah katalonskega celinskega pobočja. Njena telesna znamenja in diagnostične značilnosti se niso bistveno razlikovale of tistih pri drugih odraslih primerkih te vrste, razen njena prva hrbtna in repna plavut. Prva je bila*

močno okrnela, medtem ko se repna krpica sploh ni razvila. Avtorji so mnenja, da bi ti deformaciji, ki sicer nista zmanjševali biološke učinkovitosti vrste, lahko bili posledica genetske mutacije.

Ključne besede: *Scyliorhinus canicula,* netipične značilnosti, hrbtna plavut, repna plavut, Sredozemsko morje

REFERENCES

Abe, T. (1972): On a cyclopic embryo of the blue shark. Uo, 9, 3.

Allué, C. (1985): Composición y estructura de la comunidad de peces demersales frente a Barcelona (Años 1980-1981). Thalassas, (3) 1, 57-90.

Arthur, D. R. (1950): Abnormalities in the sexual apparatus of the common dogfish *(Scyliorhinus canicula).* Proc. Linn. Soc. Lond., 162, 52-56.

Bakhshi, P. L. & D. B. Saxena (1966): Observations on an abnormal shark, *Scoliodon walbeehmi.* Proc. Nat. Acad. Sci. India, sect. B (Biol. Sci.), 36 (1), 85-88.

Barrull, J. & I. Mate (1996): Els taurons dels Països Catalans. Ed. Pòrtic, Barcelona.

Barrull, J., I. Mate & M. Bueno (1999): Observaciones de tiburones (Chondrichthyes Euselachii) en aguas de Cataluña (Mediterráneo NO), con algunos aspectos generales de su ecología. Scientia gerundensis, 24,127-151.

Bensam, P. (1965): On a freak embryo of the grey shark, *Carcharhinus limbatus* M. & H. J. Mar. Biol. Ass. India, 7(1), 206-207.

Bini, G. (1967): Atlante dei pesci delle coste italiane. Vol. I Leptocardi, Ciclostomi, Selaci. Ed. Mondo Sommerso, Roma.

Cadenat, J. (1960): Notes d'ichthyologie ouest-africane. XXXII. Sur un cas d'intersexualité chez un requin de l'espèce *Centrophorus granulosus* B. & C., 1864. Bull. Ins. Franc. Afr. Noire (A) 24: 55-579.

Capapé, C. (1974): Systématique, écologie et biologie de la reproduction des Sélaciens des côtes tunisiennes. Thèse de spécialité (3e cycle). Université de Paris VI.

Capapé, C., A. Chadli & A. Baouendi (1979): Cas d'hermafroditisme chez *Scyliorhinus stetellaris* (Linné, 1758) (Pisces, Scyliorhin idea). Etude morphologique et histiologique. Arch. Inst. Pasteur, Tunis, 56 (53): 343-351.

Capapé, C & J. P. Zahnd (1974): Cas d'hermaphroditisme chez *Scyliorhinus canicula* (Linné, 1758). Bull Inst. Océanogr. Pêche. Salammbô, 3(1-4), 131-137.

Capapé, C. & G. Pantoustier (1975): Anomalies chez quelques Sélaciens des côtes Tunisiennes. Arch. Inst. Pasteur Tunis, 52 (3), 251- 262.

Clark, E. (1964): Spinal deformity noted in a bull shark. Underw. Nat., 2 (3), 25-28.

Compagno, L. J. V (1984a): FAO species catalogue. Vol. 4. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Part 1. Hexanchiformes to Lamniformes. FAO Fish. Synop., 125 (4), 1-249.

Compagno, L. J. V (1984b): FAO species catalogue. Vol. 4. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Part 2. Carcharhiniformes. FAO Fish. Synop., 125 (4), 251-655.

D'Onghia, G., A. Matarrese, A. Tursi & L. Sion (1995): Observations on the depth distribution pattern of the small-spotted catshark in the North Aegean Sea. Journal of Fish Biology, 47, 421-426.

Fuller, G. R. (1961): An intra-pericardial hepatic intrusion in the common dogfish. Nature, 192 (4799), 280.

Heupel, M. R., C. A. Simpfendorfer & M. B. Bennett (1999): Skeletal deformities in elasmobranchs from Australian waters. Journal of Fish Biology, 54, 1111-1115.

King, A. D. (1966): Hermaphroditism in the common dogfish (*Scyliorhinus canicula*). J. Zool., 148, 312-314.

López, A., J. Barrull & I. Mate (1996): Feridas e cicatrices nos corpos dos cetáceos varados en Galicia como indicio de depredación e de alimentación baseada en preas, principalmente por quenllas. Eubalena, 9, 10-21.

Lozano Cabo, F. (1945): Nota sobre un caso de bicefalismo en el *Squalus blainvillei.* Bol. Real. Soc. esp. Hist. nat., 43, 147-148.

Lloris, D. (1977): Tipificación y distribución de la ictiofauna del mar Catalán en relación con los tipos de plataforma y naturaleza del fondo. Tesis de Licenciatura. Facultad Biología, Universidad de Barcelona.

McKenzie, M. D. (1970): First record of albinism in the hammerhead shark, *Sphyrna lewini* (Pisces, Sphyrnidae). J.Elisha Mitchell Sci. Soc., 86 (1): 35-37.

Menon, M. D. (1957): On some abnormal sharks preserved at the Marine Biological station West Hill. J. Zool. Soc. India, 9, 200-207.

Moreno, J. A. & A. Hoyos (1982): La reproducción de los tiburones. Quercus, 7, 28-30.

Nakaya, K. (1973): An albino zebra shark, *Stegosoma fasciatum,* from the Indian ocean, with comments on albinism in elasmobranch. Japan. J. Ichthyol., 20 (2), 120-122.

Punnet, R. C. (1901): On the composition and variation on the pelvic plexus in *Acanthias vulgaris.* Proc. Roy. Soc. (B), 68, 140-142.

Punnet, R. C. (1902): On the composition and variation on the pelvic plexus in *Acanthias vulgaris.* Proc. Roy. Soc. (B), 69, 2-26.

Quero, J. C., (1978): Sur une monstruosité de l'aiguillat *(Squalus acanthias* Linné, 1758). Ann. Soc. Sci. Nat. Charente-Maritime, 6 (5), 440-441.

Taniuchi, T. & F. Yanagisawa (1987): Albinism and lack of second dorsal in an adult tawny nurse shark, *Nebrius concolor,* from Japan. Jap. J. Ichthyol., 34 (3), 393-395.

saggio scientifico originale
ricevuto: 4. 3. 2002

UDC 597(262)

DUE CATTURE DI SQUALO BIANCO, *CARCHARODON CARCHARIAS* (LINNEO, 1758) AVVENUTE NELLE ACQUE DI MARZAMEMI (SICILIA) NEGLI ANNI 1937 E 1964

Antonio CELONA
Istituto Aquastudio, IT-98124 Messina, via Trapani n°6

SINTESI

Nel presente lavoro vengono rese note due catture di squalo bianco, Carcharodon carcharias, *avvenute nell'Agosto 1937 e nel Dicembre 1964 nelle acque di Marzamemi (Siracusa), sulla costa Sud-Orientale della Sicilia. Di entrambi gli esemplari si conoscono le modalità di cattura, le dimensioni ed i contenuti stomacali. L'esemplare del 1964 aveva nello stomaco i resti di un quadrupede terrestre, probabilmente un cane. L'esemplare del 1937, misurante 530 cm, risulta essere uno dei maschi di maggiori dimensioni noti a livello mondiale.*

Parole chiave: *Carcharodon carcharias*, squalo bianco, Marzamemi, Mare Mediterraneo

TWO CAPTURES OF THE GREAT WHITE SHARK *CARCHARODON CARCHARIAS* (LINNAEUS, 1758) IN THE WATERS OF MARZAMEMI (SICILY) IN 1937 AND 1964

ABSTRACT

In the present work, two captures of the great white shark Carcharodon carcharias *in the waters of Marzamemi (Siracusa) along the southeastern coast of Sicily (Italy) in August 1937 and December 1964 are reported. For both specimens, the modality of capture, their size and stomach contents are known. The specimen caught in 1964 had remains of a terrestrial mammal, possibly a dog, in its stomach. The 530 cm long specimen captured in 1937 seems to be one of the biggest males of this species recorded in the world so far.*

Key words: *Carcharodon carcharias*, great white shark, Marzamemi, Mediterranean Sea

INTRODUZIONE

Lo squalo bianco, *Carcharodon carcharias,* (Linneo, 1758) è una specie diffusa nelle acque calde e temperate di tutto il mondo, essendo presente negli Oceani Atlantico, Oceano Pacifico, e Indiano (Compagno, 1984). Relativamente al Mare Mediterraneo, recenti studi (De Maddalena, 2002) hanno dimostrato che, per quanto la specie vi debba essere considerata sporadica, la sua presenza è comunque relativamente più cospicua nell'ampia area che comprende la Sicilia, le acque del Canale di Sicilia sino a Malta e la Tunisia. Questa zona risulta particolarmente interessante in quanto vi è stata individuata una nursery area della specie (Cigala Fulgosi, 1990; Fergusson, 1996; Mojetta *et al.*, 1997; De Maddalena, 1999).

MATERIALI E METODI

Da qualche anno l'autore ha avviato delle ricerche sulla presenza e la cattura di squali pelagici in acque siciliane. La raccolta di dati viene svolta anche ai fini dell'ampliamento delle informazioni sulla distribuzione e la biologia della specie collezionate all'interno della Banca Dati Italiana Squalo Bianco (Italian Great White Shark Data Bank), archivio di segnalazioni di *C. carcharias* nel Mare Mediterraneo attivo dal 1996.

Lo studio viene svolto cercando di individuare il maggior numero di notizie e reperti, solitamente parti scheletriche (mascelle o denti) e documentazione fotografica. Le notizie raccolte provengono da articoli di quotidiani, collezioni museali e soprattutto da testimonianze dirette raccolte presso le vecchie famiglie di pescatori. Tale opera si sta rivelando molto efficace, soprattutto per quel che riguarda il reperimento di informazioni relative alle catture di esemplari di specie di grandi dimensioni quali lo squalo bianco e lo squalo mako dalle pinne corte, *Isurus oxyrinchus* Rafinesque, 1809, poiché il ricordo di tali eventi si conserva con maggiore facilità (Celona, 2001; Celona *et al.*, 2001; De Maddalena *et al.*, 2001). Le informazioni raccolte vengono sempre verificate attraverso confronti tra i resoconti di vari soggetti.

Per quanto riguarda in particolare lo squalo bianco, recentemente si è avuto modo di raccogliere documentazione fotografica e testimonianze relative a due grossi esemplari pescati negli anni 1937 e 1964 nelle acque antistanti Marzamemi (Siracusa), nelle acque della Sicilia Sud-Orientale. In entrambi i casi le notizie raccolte risultano sufficientemente dettagliate. Sulla cattura del 1937 si sono avute numerose informazioni dai pescatori locali e si è potuta reperire documentazione fotografica. Nel caso della cattura del 1964, le numerose testimonianze dei pescatori e soprattutto del Sig. O. Garofalo, proprietario del peschereccio, sono inoltre suffragate da un articolo pubblicato su un quotidiano

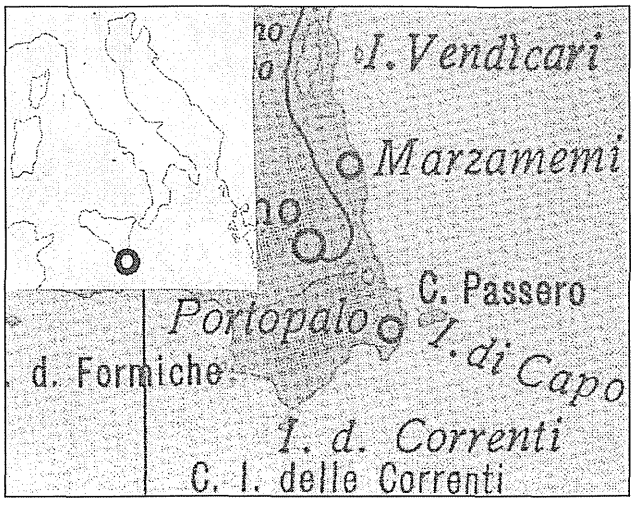


Fig. 1: Cartina di Marzamemi (Siracusa, Sicilia).
Sl. 1: Zemljevid obravnavanega območja v predelu Marzamemija blizu Siracuse (Sicilija).

dell'epoca (Marino, 1965) e anche in questo caso si ha quindi documentazione fotografica. Per entrambi i casi si sono interpellati inoltre alcuni testimoni che erano presenti al momento degli sbarchi.

RISULTATI

All'alba del 23 agosto del 1937 i pescatori del motopeschereccio "Sansone", che lavoravano per conto degli stabilimenti L.I.P. (Lavorazione Italiana Pesce), erano impegnati in una battuta di pesca con una rete a circuizione, adoperata per catturare pesce azzurro, per lo più sardine, *Clupea pilchardus* (Walbaum, 1792), denominata "cianciolo". Si trovavano ad una distanza di circa 500 metri dalla costa di Marzamemi (Fig. 1), dove la profondità del mare era di circa 35 metri. Dopo aver calato la rete, i pescatori iniziarono a recuperarla ma, nel momento in cui questa ebbe formato una sorta di sacco, emerse dalle acque un grande squalo bianco, verosimilmente attratto dalla cospicua quantità di pesce intrappolata nella rete. Lo squalo iniziò ad addentare la rete, fino a quando vi rimase esso stesso impigliato. I pescatori presero allora a colpirlo con delle aste di legno e quindi con un arpione; l'animale impiegò lungo tempo a morire. A quel punto i pescatori, resisi conto delle ragguardevoli dimensioni del pesce, decisero di trainarlo fino al porto essendo impossibile issarlo a bordo (Fig. 2). La lunghezza totale dello squalo, misurata dalla punta del muso all'apice del lobo superiore della pinna caudale, era di 530 cm, mentre il peso, relativo all'animale non sviscerato, risultò essere 1.200 kg. Si trattava di un esemplare maschio. Quando l'animale venne eviscerato, si constatò che lo stomaco appariva vuoto, non contenendo alcun resto riconoscibile.

Fig. 2: Esemplare di squalo bianco, *Carcharodon carcharias,* ***catturato nel 1937. (Foto riprodotta per gentile concessione del dott. Sessa)***
Sl. 2: Primerek belega morskega volka *Carcharodon carcharias,* ***ujetega leta 1937. (Fotografijo odstopil dr. Sessa)***

Una mattina del dicembre 1964 (probabilmente sul finire del mese), i quattro componenti del motopeschereccio "Nella" si recarono circa cinque miglia al largo di Marzamemi per recuperare le nasse dei gamberi che avevano calato il giorno precedente ad una profondità di circa 150 metri. Dopo qualche minuto che ebbero iniziato il recupero, i pescatori videro emergere la massiccia mole di uno squalo bianco, rimasto impigliato con la pinna caudale al cavo d'acciaio da 6 mm delle nasse. L'animale era già morto e presentava i segni di alcuni ampi morsi sulle pinne, in particolare in corrispondenza della pinna caudale, che apparivano causati da altri squali. I pescatori hanno dichiarato che la lunghezza dell'esemplare era di circa 5 metri ed il peso di 800 kg. Al momento dell'eviscerazione vennero rinvenuti alcuni resti di un quadrupede (ossa e pelo), che presumibilmente dovevano appartenere ad un cane (un cane lupo, secondo Marino, 1965). Secondo la testimonianza raccolta i denti maggiori dello squalo avevano una lunghezza di almeno 4 cm. Il sesso dell'esemplare rimane ignoto, non essendo tralaltro osservabile dall'unica fotografia che si è potuta reperire.

Successivamente lo squalo venne fatto a pezzi: in parte venne venduto per il consumo umano e in parte fu utilizzato come esca per le nasse.

DISCUSSIONE

Per quanto concerne l'esemplare catturato nel 1937, è interessante notare che, sulla base dei dati riportati in letteratura (Ellis & McCosker, 1991; Mollet *et al.*, 1996; De Maddalena *et al.*, 2001; De Maddalena, 2002), tale esemplare risulta essere uno dei maschi più grandi di questa specie segnalati sino a questo momento a livello globale. Le dimensioni dell'animale testimoniate dalla fotografia sono d'altra parte aderenti alla lunghezza totale indicata dai testimoni. Si aggiunga che il peso riportato è compatibile con le stime effettuate da Mollet & Cailliet (1996).

Per quanto riguarda l'esemplare del 1964, la lunghezza riportata è approssimativa, e la fotografia reperita non permette di effettuare una valida stima. Il peso riportato, pari a 800 kg, lascia solo ipotizzare una lunghezza totale forse più vicina ai 4,4 metri, in base ai dati indicati da Mollet & Cailliet (1996), ma con le riserve dovute al fatto che non essendo nota la circonferenza non è possibile ritenere precisa una stima effettuata dal solo peso.

Sebbene risulti curioso il ritrovamento delle parti di un mammifero terrestre, probabilmente un cane, nello stomaco dell'esemplare del 1964, la varietà della dieta dello squalo bianco è tale che un caso di questo genere non costituisce invero una rarità. Esistono diversi resoconti inerenti al ritrovamento di mammiferi terrestri negli stomaci di squali bianchi, e cani, gatti e una capra sono in passato già stati riportati per esemplari pescati in acque italiane (Condorelli & Perrando, 1909; De Maddalena, 2002). D'altra parte nulla indica che il cane sia stato attaccato quando era ancora in vita e non piuttosto che si sia trattato, come più probabile, di alimentazione su di una carcassa.

In merito ai segni di morsi osservati sul medesimo squalo, dalla scarna descrizione fattane dai testimoni, si deduce che si sia potuto trattare in parte di "morsi d'amore" causati da un conspecifico ai fini di un corteggiamento, e in parte di ferite provocate da squali (della stessa o di altre specie) che avevano avvicinato l'esemplare, morto o morente, per cibarsene. Lo squalo, evidentemente cercando di liberarsi dal cavo in cui era rimasto preso, si era procurato diverse ferite, ed il sangue aveva dovuto attrarre sul posto gli altri squali.

Queste segnalazioni sono un ulteriore conferma del fatto che la presenza di squali bianchi in queste acque, abitualmente frequentate da numerosi tonni, delfini, pesci spada e tartarughe marine (che, com'è noto, costituiscono una parte fondamentale del regime alimentare degli squali bianchi nel Mediterraneo (Fergusson, 1996; De Maddalena, 1999), erano un tempo relativamente ricorrenti.

RINGRAZIAMENTI

Per il cortese aiuto fornito nella raccolta delle informazioni inerenti alle catture degli squali bianchi e per i consigli dati durante la preparazione di questa nota, l'autore desidera ringraziare le seguenti persone: Antonio Di Natale, Alessandro De Maddalena, Emilio Sessa, Orazio Garofalo, Nuccio Marino.

O DVEH BELIH MORSKIH VOLKOVIH *CARCHARODON CARCHARIAS* (LINNAEUS, 1758), UJETIH V V LETIH 1937 IN 1964 V VODAH BLIZU MARZAMEMIJA (SICILIJA)

Antonio CELONA
Istituto Aquastudio, IT-98124 Messina, via Trapani n°6

POVZETEK

Avtor opisuje dva primerka belega morskega volka (Carcharodon carcharias), *ujeta avgusta leta 1937 in decembra 1964 v vodah blizu Siracuse na Siciliji. Osebek iz leta 1964 je imel v želodcu ostanke kopenskega štirinožca, najverjetneje psa. Osebek iz leta 1937, ki je meril 530 cm in tehtal 1200 kg, pa je eden večjih do danes na svetu ujetih in izmerjenih belih morskih volkov.*

Ključne besede: *Carcharodon carcharias*, beli morski volk, Marzamemi, Sredozemsko morje

BIBLIOGRAFIA

Celona, A. (2001): Su due esemplari di squalo bianco, (*Carcharodon carcharias*) (Linneo, 1758) catturati nello Stretto di Messina nel 1913 e nel 1961. *Annali del* Museo Civico di Storia Naturale "G. Doria". *In press.*

Celona, A., N. Donato & A. De Maddalena (2001): In relation to the captures of a great white shark, *Carcharodon carcharias* (Linnaeus, 1758), and a shortfin mako, *Isurus oxyrinchus* (Rafinesque, 1809), in the Messina Strait. Annales, Series historia naturalis, 11 (1), 13-16.

Cigala Fulgosi, F. (1990): Predation (or possible scavenging) by a great white shark on an extinct species of bottlenosed dolphin in the Italian Pliocene. Tertiary Research, 12(1), 17-36.

Compagno, L. J. V. (1984): FAO species catalogue Vol. 4 Sharks of the world. An annotated and illustrated catalogue of sharks species know to date. Part 1. Hexanchiformes to Lamniformes. FAO Fisheries Synopsis, (125), 1-249.

Condorelli, M. & G. G. Perrando (1909): Notizie sul *Carcharodon carcharias* L. catturato nelle acque di Augusta e considerazioni medico-legali sui resti umani trovati nel tubo digerente. Bollettino della Società Zoologica Italiana, 1909, 164-183.

De Maddalena, A. (1999): Records of the great white shark in the Mediterranean Sea. Private publication, Milano.

De Maddalena, A. (2002): Lo squalo bianco nei mari d'Italia. Ireco, Formello.

De Maddalena A., M. Zuffa, L. Lipej & A. Celona (2001): An analysis of the photographic evidences of the largest great white sharks, *Carcharodon carcharias* (Linnaeus, 1758), captured in the Mediterranean Sea with considerations about the maximum size of the species. Annales, Series historia naturalis, 11(2), 193-206.

Ellis, R. & J. E. McCosker (1991): Great white shark. Stanford, Stanford University Press.

Fergusson, I. K. (1996): Distribution and autecology of the white shark in the Eastern North Atlantic Ocean and the Mediterranean Sea. In: Klimley, A. P. & D.G. Ainley (eds): Great white sharks. The biology of *Carcharodon carcharias*. Academic press, San Diego, 321-345.

Marino, N. (1965): Un pescecane di otto quintali catturato nella "secca" di Marzamemi. Corriere di Sicilia, Gennaio 1965.

Mojetta, A., T. Storai, & M. Zuffa (1997): Segnalazioni di squalo bianco (*Carcharodon carcharias*) in acque italiane. Quaderni della Civica Stazione Idrobiologica di Milano, 22, 23-38.

Mollet, H. F. & G. M. Cailliet (1996): Using allometry to predict body mass from linear measurements of the white shark. In: Klimley, A. P. & D. G. Ainley (eds.): Great white sharks. The biology of *Carcharodon carcharias*. San Diego, Academic Press, 81-90.

Mollet, H. F., G. M. Cailliet, A. P. Klimley, D. A. Ebert, A. D. Testi & L. J. V. Compagno (1996): A review of length validation methods and protocols to measure large white sharks. In: Klimley, A. P. & Ainley, D. G. (eds.): Great white sharks. The biology of *Carcharodon carcharias*. San Diego, Academic Press, 91-108.

original scientific paper
received: 8. 1. 2002

UDC 597.3(262-11)

CAPTURE OF A FEMALE BASKING SHARK, *CETORHINUS MAXIMUS* (GUNNERUS, 1765), FROM SOUTHERN TURKEY

Hakan KABASAKAL
Ichthyological Research Society, Atatürk mahallesi, Menteşoğlu caddesi,
İdil apt., No 30, D 4, TR-Ümraniye 81230 Istanbul
E-mail: hakankabasakal@hotmail.com

ABSTRACT

On December 2001, a subadult female basking shark (Cetorhinus maximus) *was accidentally captured in a gill-net set for the bonito only 100 metres off the shore in the Gulf of Antalya (southern Turkey). This is the second confirmed record of this shark from the seas of Turkey.*

Key words: basking shark, *Cetorhinus maximus*, Turkish seas, gill-net fishery

CATTURA DI UNA FEMMINA DI SQUALO ELEFANTE *CETORHINUS MAXIMUS* (GUNNERUS, 1765) NELLA TURCHIA MERIDIONALE

SINTESI

Nel dicembre 2001 una femmina subadulta di squalo elefante (Cetorhinus maximus) *è stata catturata accidentalmente in un tramaglio per scombridi, ad appena 100 metri dalla riva nel Golfo di Antalya (Turchia meridionale). La cattura dell'esemplare risulta essere il secondo avvistamento confermato per tale specie nei mari della Turchia.*

Parole chiave: squalo elefante, *Cetorhinus maximus*, mari della Turchia, pesca con tramaglio

INTRODUCTION

Basking shark, *Cetorhinus maximus* (Gunnerus, 1765), is the largest of all Mediterranean sharks (Quéro, 1984). Most basking sharks are under 9 m in length, but some may grow to 15 m (Compagno, 1984). It is a typical planktivorous shark and its seasonal and regional occurrence is well correlated with zooplankton density (Sims *et al.*, 1997). Although local records of the basking sharks throughout the Mediterranean Sea are well documented (see, for example, Lipej *et al.*, 2000 in Adriatic Sea; Najai, 1980 in Tunisian waters; Podesta & Magnaghi, 1988 in Italian waters), there is almost no information available concerning its presence along the coast of Turkey. The only previous local record of the basking shark is from Gulf of Iskenderun (eastern Mediterranean coast of Turkey) (Kıdeyş, 1997). Therefore, it is not clear whether the occurrence of the basking shark in the seas of Turkey is incidental or exhibits a seasonal regularity.

In ecological terms, the basking shark is considered a typical '*k-selected species*' because of its slow rates of growth, attaining the first maturity at a very late age and giving birth in very small numbers. Parker & Stott (1965) suggest a 3.5 years gestation period for the basking shark. It is therefore one of the shark species most vulnerable to over-fishing and today it is one of the threatened species of elasmobranchs mentioned in the *IUCN Red List of Threatened Animals* (Fowler, 1996). Due to the above reasons, local populations of basking sharks should be monitored carefully.

The present paper aims to make a contribution to the knowledge of sharks occurring in the seas of Turkey.

MATERIAL AND METHODS

A female basking shark has been accidentally captured on December 2001 in a gill-net set for bonito only 100 m off the shore (depth nearly 7 m) in the Gulf of Antalya (36°32'01'', N 30°31'02'' E; Fig. 1). Body measurements were taken with a hand meter following the guidelines by Compagno (1984). Unfortunately, the shark has been immediately sold at the fish market and therefore it was not possible to examine the internal organs of the specimen.

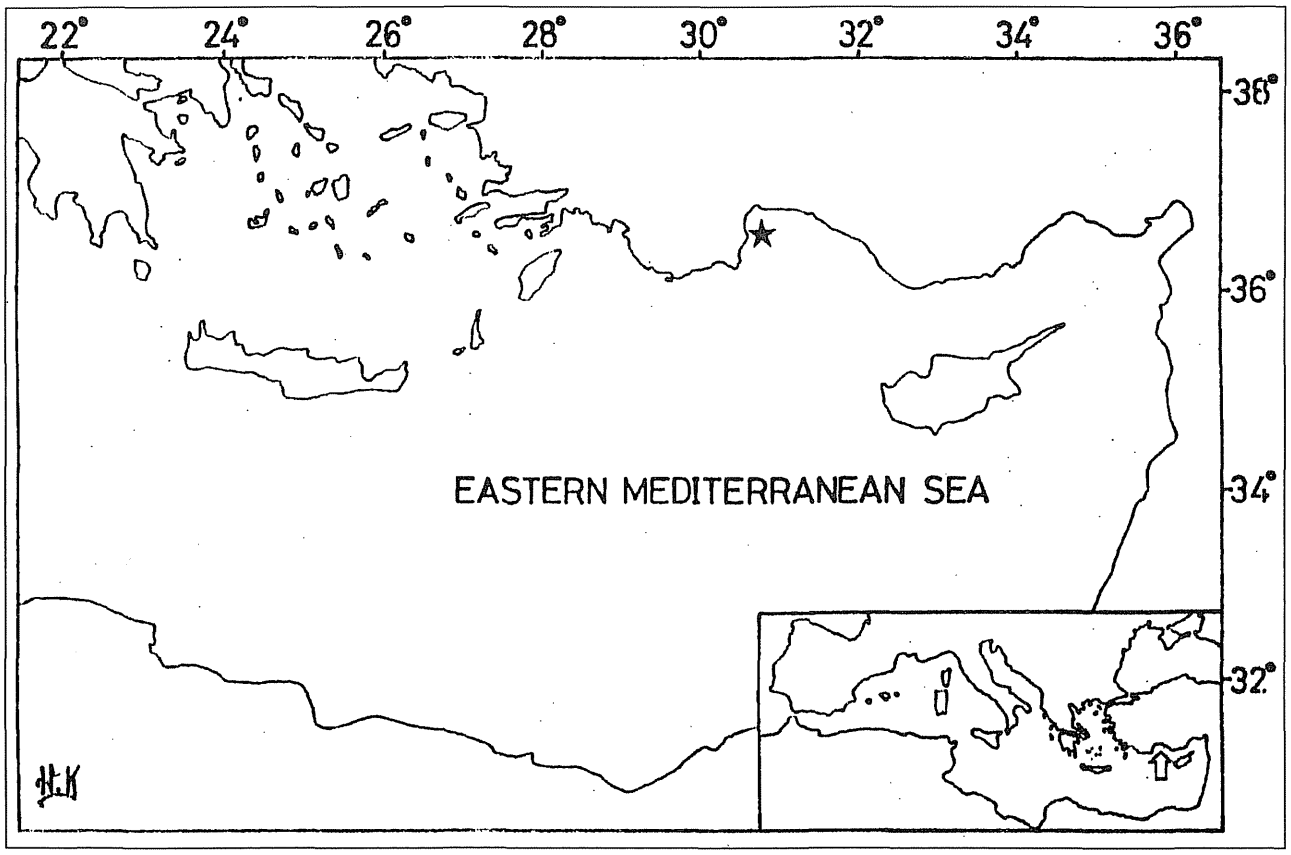


Fig. 1: Location of the sampling site (★) in the Gulf of Antalya.
Sl. 1: Lokacija vzorčišča (★) v Antalijskem zalivu.

Tab. 1: Body measurements of the female basking shark** (Cetorhinus maximus), **accidentally captured in the Gulf of Antalya.
Tab. 1: Mere samice morskega psa orjaka** (Cetorhinus maximus), **naključno ujete v Antalijskem zalivu.

Measurement	cm	% of TL
Total length	600	-
Girth in front of the 1st dorsal fin	205	34.16
Length of the 1st dorsal fin	98	16.33
Length of the 2nd dorsal fin	60	10
Distance between the 1st dorsal and pelvic fins	97	16.16
Dorsal caudal margin	145	24.16
Ventral caudal margin	90	15
Preorbital length	45	7.5

RESULTS AND DISCUSSION

This specimen of the basking shark entangled in a gill-net in the Gulf of Antalya is the second confirmed recording of this species from the seas of Turkey. Body measurements of the specimen are given in Table 1.

Basking sharks are known to become mature when reaching the length between 8.1 and 9.8 m (Compagno, 1984). Therefore, it could be assumed that the female basking shark (6 m TL) captured in the Gulf of Antalya is a subadult individual.

Although Parker & Boeseman (1954; *sensu* Sims *et al.*, 1997) proposed that basking sharks migrate from coastal to deep waters in September and October, no information is available to explain the reasons for the winter occurrence of this female basking shark in the shallow coastal waters. However, migrations of the basking sharks in the seas of Turkey, particularly in the coastal waters where an intensive gill-net fishery is carried out, should be determined in detail for reducing the possible impacts of by-catching on this vulnerable shark.

SAMICA MORSKEGA PSA ORJAKA *CETORHINUS MAXIMUS* (GUNNERUS, 1765), UJETA V VODAH JUŽNE TURČIJE

Hakan KABASAKAL
Ichthyological Research Society, Atatürk mahallesi, Menteşoğlu caddesi,
İdil apt., No 30, D 4, TR-Ümraniye 81230 Istanbul
E-mail: hakankabasakal@hotmail.com

POVZETEK

Decembra leta 2001 se je v stoječo mrežo palamidarico, postavljeno 100 m od obrežja v Antalijskem zalivu (južna Turčija), ujela samica morskega psa orjaka (Cetorhinus maximus). *To je drugi potrjeni zapis morskega psa orjaka iz turških voda. Glede na njeno celotno dolžino (6 m) gre bržkone za skoraj odrasel osebek. Avtor meni, da bi bilo nujno skrbno spremljanje morskega psa orjaka v turških vodah, da bi se zmanjšal vpliv v mreže naključno ujetih osebkov na tega ranljivega morskega psa.*

Ključne besede: morski pes orjak, *Cetorhinus maximus*, turške vode, ribolov s stoječimi mrežami

REFERENCES

Compagno, L. J. V. (1984): FAO Species Catalogue. Vol. 4: Sharks of the world. An annotated and illustrated Catalogue of Shark Species Known to Date. Part 1. Hexanchiformes to Lamniformes. Rome, 249 pp.

Fowler, S. (1996): Red List assessments for sharks and rays. Shark News, 8, 4-5.

Kıdeyş, A. E. (1997): Occurrence of the basking shark, *Cetorhinus maximus* in the northern Levantine, the eastern Mediterranean. The International Mediterranean Fisheries Congress, University of Ege, Faculty of Fisheries, Izmir, Book of Abstracts, p. 120.

Lipej, L., T. Makovec, M. Orlando & V. Žiža (2000): Occurrence of the basking shark, *Cetorhinus maximus* (Gunnerus, 1765), in the waters off Piran (Gulf of Trieste, Northern Adriatic). Annales Ser. hist. nat. 10, 2(21), 211-216.

Najai, S. (1980): Note sur la présence de deux requins pélerins dans le golfe de Tunis. Bull. Inst. nat. scient. tech. Océanogr. Pêche Salammbô, 7, 151-152.

Parker, H. W. & M. Boeseman (1954): The basking shark *(Cetorhinus maximus)* in winter. Proceedings of the Zoological Society of London, 124, 185-194.

Parker, H. W. & F. C. Stott (1965): Age, size and vertebral calcification in the basking shark, *Cetorhinus maximus* (Gunnerus). Zoologische Mededelingen, 40(34), 305-319.

Podestà, M. & L. Magnaghi (1988): Cattura di un *Cetorhinus maximus* (Gunner, 1765) nel mar Ligure. Atti Soc. ital. Sci. nat. Museo civ. Stor. nat. Milano, 129(4), 453-458.

Quéro, J. -C. (1984): Cetorhinidae. In: Whitehead, P. J. P., M. -L. Bauchot, J. -C. Hureau, J. Nielsen & E. Tortonese (eds.): Fishes of the North-eastern Atlantic and the Mediterranean. Vol. I, UNESCO, Paris, 89-90.

Sims, D. W., A. M. Fox & D. A. Merrett (1997): Basking shark occurrence off south-west England in relation to zooplankton abundance. Journal of Fish Biology, 51, 436-440.

original scientific paper
received: 11. 3. 2002

UDC 597.5(262.3-11)

ANALYSIS OF THE VERTEBRAL NUMBER IN GILT SARDINE *SARDINELLA AURITA* VALENCIENNES, 1847 AND ALLIS-SHAD *ALOSA FALLAX NILOTICA* (LACÈPEDE, 1803) FROM THE EASTERN CENTRAL ADRIATIC

Jakov DULČIĆ
Institute of Oceanography and Fisheries, HR-21000 Split, P.O. Box 500
E-mail: dulcic@izor.hr

ABSTRACT

Samples of the gilt sardine catches with a total of 50 individuals from the channel area (Hvar Channel) and open waters (Palagruža Island) of the central Adriatic were analysed with respect to their number of vertebrae. The vertebral number in gilt sardines ranged from 47 to 49. Modal value of 48 vertebrae was observed in all the samples of gilt sardine catches. Samples of the allis shad catches with a total of 76 individuals from the inshore waters (Saldun and Marina Bays) and offshore waters (Jabuka Island) were also analysed with respect to their number of vertebrae. The vertebral number of allis shad ranged from 54 to 57. Modal value of 57 vertebrae was observed in all the samples of the allis shad catches. There was no significant difference between the mean values of vertebrae for both species. It could be concluded that the tested gilt sardine and allis shad samples from the investigated regions belonged to the same populations as regards their number of vertebrae, respectively.

Key words: *Sardinella aurita, Alosa fallax nilotica,* vertebral number, eastern central Adriatic

ANALISI DEL NUMERO DI VERTEBRE DI ALACCIA *SARDINELLA AURITA* (VALENCIENNES, 1847) E CHEPPIA *ALOSA FALLAX NILOTICA* (LACÈPEDE, 1803) IN ADRIATICO CENTRO-ORIENTALE

SINTESI

È stato analizzato il numero di vertebre di campioni di pescate di alaccia, per un totale di 50 individui, provenienti dall'area del canale (canale di Lesina) e dal mare aperto (isola di Pelagosa). Il numero di vertebre dell'alaccia è variato da 47 a 49. Il valore modale di 48 vertebre è stato riscontrato in tutti i campioni di pescate di alaccie. È stato inoltre analizzato il numero di vertebre di campioni di pescate di cheppia, per un totale di 76 individui, provenienti da acque vicine alla riva (baie di Saldun e Marina) e da acque al largo (isola di Jabuka). Il numero di vertebre della cheppia è variato da 54 a 57. Il valore modale di 57 vertebre è stato riscontrato in tutti i campioni di pescate di cheppie. Non è stata registrata alcuna differenza significativa tra i valori medi delle vertebre di entrambe le specie. L'autore conclude che, visto il numero di vertebre registrato, i campioni di alaccia e cheppia analizzati appartengono rispettivamente alle stesse popolazioni.

Parole chiave: *Sardinella aurita, Alosa fallax nilotica,* numero di vertebre, Adriatico centro-orientale

INTRODUCTION

The differences between the length distribution of gilt sardine *Sardinella aurita* Valenciennes, 1847 and allis-shad *Alosa fallax nilotica* (Lacèpede, 1803) taken from the inshore and offshore waters of the central Adriatic (Kačić, 1975; Morović, 1958) indicated a possibility of heterogeneous gilt sardine and allis-shad populations existence.

The number of vertebrae is a meristic character previously used at population identification (Piccinetti, 1971; Krajnović-Ozretić & Žikić, 1978; Sinovčić, 1982; Dulčić *et al.*, 1994). The same meristic character was applied in this work.

Various experiments have shown that the vertebral number is genetically fixed with narrow limits, and that minor aberrations are due to the influence of different environmental factors, especially temperature in the so-called sensitive time (Lindsay, 1954; Blaxter, 1957), which is different for each species. However, it is apparent that the statistic different number of vertebrae represents an independent population (Larrańeta, 1958).

The purpose of the present study is to analyse the number of vertebrae in gilt sardine and allis-shad from the inshore and offshore waters of the central Adriatic, since there are no precise data on the vertebral number of gilt sardine and allis-shad from the eastern Adriatic.

MATERIAL AND METHODS

Samples of the gilt sardine catches were taken from the channel area (Hvar Channel) and open waters (the region of Palagruža Island), while those of allis shad were obtained from the inshore (Saldun and Marina Bay) and open waters (the region of Jabuka Island) in the central Adriatic (Fig. 1). Six representative samples of catches with a total of 50 individuals of the gilt sardine and 76 individuals of the allis shad were taken during 1997. The number of individuals varied from 7 to 15 for the gilt sardine, and from 9 to 13 for the allis shad in some samples of the catches.

Fish were preserved in 4% formaldehyde and, after dissection, air-dried for one to two days. The vertebrae were counted by lens, from occipital condyle (not counted) to urostyle (included), as recommended by FAO Fisheries Division.

The samples were also analysed statistically. Mean numbers of vertebrae, standard deviation and standard errors of arithmetic means were calculated. Analyses of variance and Fisher's F test were also applied to determine the significant differences between variances. Obtained F values were compared to those of the limited values F, at a 5% significance level.

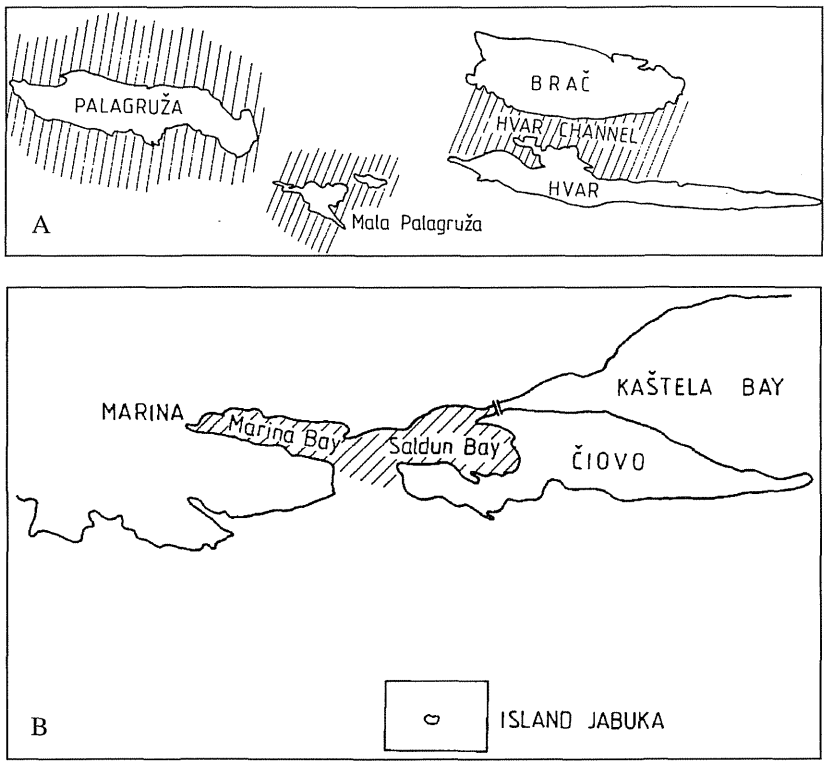


Fig. 1: Location of sampling stations of the gilt sardine (A) and allis shad (B) in the eastern central Adriatic.
Sl. 1: Lokacije vzorčišč za veliko sardelo (A) in čepo (B) v vzhodnem srednjem Jadranu.

RESULTS AND DISCUSSION

Total length of the gilt sardines from the Hvar Channel used in the analysis of the vertebral number varied from 197 to 279 mm (mean value = 248±0.44), and from 156 to 224 mm (mean value = 183±0.39) of those from open waters. Total length of allis shad from Saldun and Marina Bays varied from 137 to 425 mm (mean value = 289±0.77), and from 186 to 386 mm (mean value = 267±0.59) for those from Jabuka Island.

The total vertebral number of gilt sardine from the channel area and open waters of the central Adriatic ranged from 47 to 49 (mean value = 48.22±0.67, SE = 0.08, coefficient of variability = 1.39). The vertebral number in gilt sardines from the Hvar Channel ranged from 47 to 49 (48.20±0.84, SE = 0.07, coefficient of variability = 1.74), and from 48 to 49 (mean value = 48.25±0.50, SE = 0.06, coefficient of variability = 1.04) in those from Palagruža Island. There was no significant difference between mean values (t = 0.11, P>0.05), so it can be concluded that there are no statistically significant differences in the vertebral number in gilt sardines from the channel area in relation to those from the open waters. There were no such differences between vertebral numbers in gilt sardines from the catch samples within the same regions. It could be concluded that the tested gilt sardine samples from both regions belonged to the same population as regards their number of vertebrae. Modal value of 48 vertebrae was observed in all samples of the gilt sardine catches. Besides that modal class, the class 48 showed the highest frequency and the class 49 appeared rarely just in the channel area. Similar vertebral number means in gilt sardines have been observed by several authors (Fage, 1920; Navarro, 1927, 1932; Quignard & Kartas, 1974) for the Almeira region, Algerian coastal waters, Canarian archipelago and Tunisian waters. Navarro (1948) and Oliver & Navarro (1952) reported the widest ranges of vertebrae (45-52 and 45-50) for Balearic Islands.

The total vertebral number in allis shad from the inshore and offshore waters of the central Adriatic ranged from 54 to 57 (mean value = 56.10±0.99, SE = 0.11, coefficient of variability = 1.76). The vertebral number of allis shad from Saldun and Marina Bays ranged from 55 to 57 (mean value = 56.25±0.94, SE = 0.06, coefficient of variability = 1.67) and from 54 to 57 (mean value = 56.14±1.27, SE = 0.13, coefficient of variability = 2.25) for those from Jabuka island. There was no significant difference between mean values (t = 0.18, P>0.05), so it can be concluded that there are no statistically significant differences in the vertebral number of allis shad from inshore waters in relation to the allis shad from offshore waters. There were no such differences between vertebral numbers of allis shad from the catch samples within the same regions. It could be concluded that the tested allis shad samples from both regions belonged to the same population as regards their number of vertebrae. Modal value of 57 vertebrae was observed in all samples of the allis shad catches. There are no data about the vertebral number of allis shad from the Adriatic Sea, but there are some data from freshwaters. Vuković (1961) reported the number of vertebrae for Skadar Lake (47-60), Baćinska Lakes (48-60) and River Neretva Estuary (53-60). Ivanović (1973) noted that the total number of allis shad from the Skadar Lake ranged from 55 to 60.

ANALIZA ŠTEVILA VRETENC V VELIKIH SARDELAH *SARDINELLA AURITA* VALENCIENNES, 1847 IN ČEPAH *ALOSA FALLAX NILOTICA* (LACÈPEDE, 1803) IZ VZHODNEGA SREDNJEGA JADRANA

Jakov DULČIĆ
Inštitut za oceanografijo in ribištvo, HR-21000 Split, p.p. 500
E-mail: dulcic@izor.hr

POVZETEK

Avtor je ugotavljal število vretenc v velikih sardelah in čepah, ujetih v vzhodnem srednjem Jadranu. Pri analizi 50 primerkov velike sardele iz Hvarskega kanala in odprtega morja (iz okolice Palagruže) se je število vretenc gibalo med 47 in 49, medtem ko je bilo modalno število pri vseh primerkih 48 vretenc. Pri analizi 76 primerkov čep iz obalnih voda (zalivov Saldun in Marina) in odprtega morja (iz okolice Jabuke) pa se je število vretenc gibalo med 54 in 57; modalno število pri vseh primerkih je bilo 57 vretenc. Avtor ni ugotovil nobene pomembne razlike med srednjimi vrednostmi pri obeh vrstah. Zatorej je bilo mogoče napraviti sklep, da so glede na število vretenc preučevani primerki velike sardele in čepe iz zgoraj omenjenih raziskanih območij pripadali istim populacijam.

Ključne besede: *Sardinella aurita, Alosa fallax nilotica,* število vretenc, vzhodni srednji Jadran

REFERENCES

Blaxter, J. H. S. (1964): Herring rearing. III. The effect of temperature and other factors on myotome counts. Mar. Res., 1, 1-16.

Dulčić J., P. Cetinić & M. Kraljević (1994): Analysis of the vertebral number of damselfish *Chromis chromis* (L.) in the central Adriatic. Acta Ichthyologica et Piscatoria, 2, 141-146.

Fage, L. (1920): Engraulidae, Clupeidae. Rep. Danish Oceanogr. Exped. 1908-10, 2 (A9), 1-140.

Ivanović, B. M. (1973): Ichthyofauna of Skadar Lake. Titograd, 64-67.

Kaćić, I. (1975): Zapažanja o srdeli golemoj *(Sardinella aurita)* u Jadranu. Morsko ribarstvo, 27 (1), 11-13.

Krajnović-Ozretić, M. & R. Žikić (1978): Analysis of the vertebral number of the sardine *(Sardina pilchardus* Walb.) from the Adriatic Sea. Thalassia Jugosl., 14, 313-321.

Larrańeta, M. G. (1958): Sur la female vertebrale de quelques poissons commerciaux des cotes de Castellon. Rapp. P. Reun. CIESM, 14, 373-377.

Lindsay, C. C. (1954): Temperature controlled meristic variation in the paradise fish *Macropodus opercularis* (L.) Can. J. Zool., 30, 87-98.

Morović, D. (1958): Lojka, ćepa, *Clupea finta* Cuv. Ribarstvo Jugoslavije, 5, 93-96.

Navarro, F. P. (1927): Estudios sobre los clupeidos de Baleares. II. La alacha *(Sardinella aurita* C.V.). Notas Inst. Esp. Oceanogr., 2 (21), 21-27.

Navarro, F. P. (1932): Nuevos estudios sobre la alacha *(Sardinella aurita* C. V.) de Baleares y de Canarias. Notas Inst. Esp. Oceanogr., 2 (60), 1-35.

Oliver, P. & F. P. Navarro (1952): Nuevos estudios sobre la alacha de Baleares. Notas Inst. Esp. Oceanogr., 82, 1-29.

Piccinetti, C. (1971): Donees preliminares sur les caracters biometriques des anchois *(Engraulis encrasicholus* L.) peches dunht Fano. Rapp. P. Reun. CIESM, 20, 473-475.

Quignard, J. P. & F. Kartas (1974): Observations sur les sardinelles des cotes Tunisiennes L'Hiver 1973-1974. CIESM, XXIV Congress, Monaco.

Sinovčić, G. (1982): On the vertebral number of anchovy *Engraulis encrasicolus* (L.) in the central Adriatic. Acta Adriat., 23, 441-448.

Vuković, T. (1961): Populacije i narešćenje *Alosa fallax nilotica* (Geoffroy) u vodama Neretve i Skadarskog jezera. God. Biol. Inst. Univ. Sarajevo, 14 (1-2), 85-178.

FLORA IN VEGETACIJA

FLORA E VEGETAZIONE

FLORA AND VEGETATION

izvirni znanstveni članek
prejeto: 20. 4. 2002

UDK 581.5:632.5(497.4-15)

OKOPAVINSKA PLEVELNA VEGETACIJA V BREGINJSKEM KOTU (ZAHODNA SLOVENIJA)

Boško ČUŠIN
Biološki inštitut ZRC SAZU, Regijska raziskovalna enota Tolmin, SI-5220 Tolmin, Brunov drevored 13

Urban ŠILC
Biološki inštitut ZRC SAZU, SI-1000 Ljubljana, Gosposka 13

IZVLEČEK

V Breginjskem kotu smo preučevali plevelno vegetacijo okopavin. Popisno gradivo smo primerjali z opisi iz Slovenije in sosednje Furlanije-Julijske krajine. Sestoje uvrščamo v asociacijo Echinochloo-Setarietum pumilae *Felföldy 1942 corr. Mucina 1993* (Stellarietea mediae). *Asociacijo smo členili v višinsko formo, ki jo označuje razlikovalna vrsta* Galeopsis tetrahit.

Ključne besede: pleveli, *Stellarietea mediae*, Breginjski kot, Slovenija

MALERBE DI TERRENI ZAPPATI NEL CANTONE DI BERGOGNA (SLOVENIA OCCIDENTALE)

SINTESI

Gli autori hanno analizzato le malerbe dei terreni zappati nel cantone di Bergogna. I campioni sono risultati appartenenti all'associazione Echinochloo-Setarietum pumilae *Felföldy 1942 corr. Mucina 1993* (Stellarietea mediae). *Il materiale è stato messo a confronto con gli elenchi della vicina regione del Friuli-Venezia Giulia.*

Parole chiave: malerbe, *Stellarietea mediae,* cantone di Bergogna, Slovenia

UVOD

Prebivalci Breginjskega kota v zahodni Sloveniji so se še pred nekaj desetletji preživljali v glavnem s kmetijstvom. Prevladovala je živinoreja, poljedelstvo je imelo manjši pomen. Ker je pokrajina hribovita, je ravnih površin, primernih za obdelovanje, razmeroma malo. Takšni območji sta Podbelsko (Bejsko) polje, veliki hudourniški vršaj reke Bele na sotočju z Nadižo in Krejsko polje na aluvialnih naplavinah reke Nadiže. V okolici drugih vasi se večina njiv razteza na blagih pobočjih, ki so bila za ta namen izravnana in imajo zdaj terasasto obliko. Na teh površinah je bil do neke mere porušen ne samo prvotni talni profil, temveč je celo geološka podlaga, ki je večinoma morena in pobočni grušč, prišla v zgornje plasti obdelovalnih površin. Večje skeletne delce ("grič") so ljudje pobirali iz preorane zemlje in jih nalagali na robove njiv. O tem pričajo še danes vidni kupčki kamenja, ki pa jih je večinoma prerasla ruša. Tako so bile vse njive pravzaprav le na ravnih, oziroma izravnanih delih in nikjer na zmerno strmih pobočjih, kar marsikje po Sloveniji vidimo še danes, npr. v dolini Idrijce. Njive so do sredine prejšnjega stoletja obdelovali le z lopato. Če si danes ogledamo območje, ki je bilo nekoč obdelovano na tako preprost način, z vso spoštljivostjo pomislimo na marljivost in težko življenje teh ljudi v polpreteklih časih, saj so Kotarji potrebovali kar mesec dni, da so "skopali" (prelopatili) svoje njive. Šele po 2. svetovni vojni so začeli orati s plugom na konjsko vprego. Najbolj pomembni poljščini sta bili krompir in koruza. Tudi danes zasledimo le dva tipa njiv. Koruzne njive so monokulture, le ob robu njiv redko opazimo fižol. Na krompirjevih njivah je bilo precej več posevkov. Vsakih nekaj metrov je njivo presekala vrsta fižola, vmes pa je bilo tudi precej korenja in repe. Buče so sadili večinoma na robu njiv, od koder so se širile na "grivo" (nezorani del njive), ki je bila zaradi nakopičenih organskih ostankov, nastalih pri čiščenju in obdelovanju njive, navadno nekoliko dvignjena. Naštete posevke so uporabljali kot hrano zase in tudi za vse živali, ki so jih imeli pri hiši (krave, svinje, drobnico, kokoši). Poskusi gojenja žit se zaradi preveč humidne klime niso obnesli, pšenica je npr. zrasla previsoko in se še nedozorela prevrnila.

Med posevki so se znašle tudi rastline, ki niso bile dobrodošle in so ovirale njihov nemoteni razvoj – pleveli. Da bi preprečili njihovo rast, so koruzo, ko je bila majhna, okopali z motiko, kasneje pa še obsuli z lopato (v novejšem času s posebnim plugom). Krompir so okopali le na začetku, kasneje, ko so zrasli tudi drugi posevki, so morali plevele ročno odstraniti. Z odstranjenimi pleveli so krmili govedo.

Najbolj pogosti pleveli imajo še danes krajevna imena. Rogovilček imenujejo "tamažin", zelo trdovratni "slanovrat" je plazeča zlatica, dresni (skupina "podobnih" vrst, ki jih uvrščamo v podrod *Persicaria*: *Polygonum persicaria, P. lapathifolium, P. mite)* pa poznajo kot "gejduc". Sama po sebi se ponuja povezava z ajdo (krajevno: "gejda"), ki so jo nekoč gojili tudi v teh krajih. Tisto, kar smo se botaniki naučili, so domačini opazili sami. Zanimivo je njihovo pričevanje, da nekoč niso opažali plevelov iz rodu *Amaranthus*, trav (predvsem vrste *Echinochloa crus-galli)* in vejicastega rogovilčka - *Galinsoga ciliata* (bil je le drobnocvetni - *Galinsoga parviflora).* Njive so gnojili izključno s hlevskim gnojem, ki je bil mešanica iztrebkov vseh domačih živali in stelje. Za steljo so uporabljali predvsem zdrobljene suhe steblike koruze in listje, ki so ga nagrabili pod leskami in črnimi jelšami (od slednjih so uporabljali tudi sesekljane mlade veje). Tla so, razen tistih na flišu (okolica vasi Logje), zelo skeletna in peščena in s hlevskim gnojem so tako v zemljo vnesli tudi prepotrebni humus. Pomanjkanje tega opazimo zlasti danes, ko primanjkuje organskih gnojil, zato so tudi mineralna gnojila manj učinkovita, saj se hitro izperejo v podtalje, prst pa je čedalje bolj pusta in peščena.

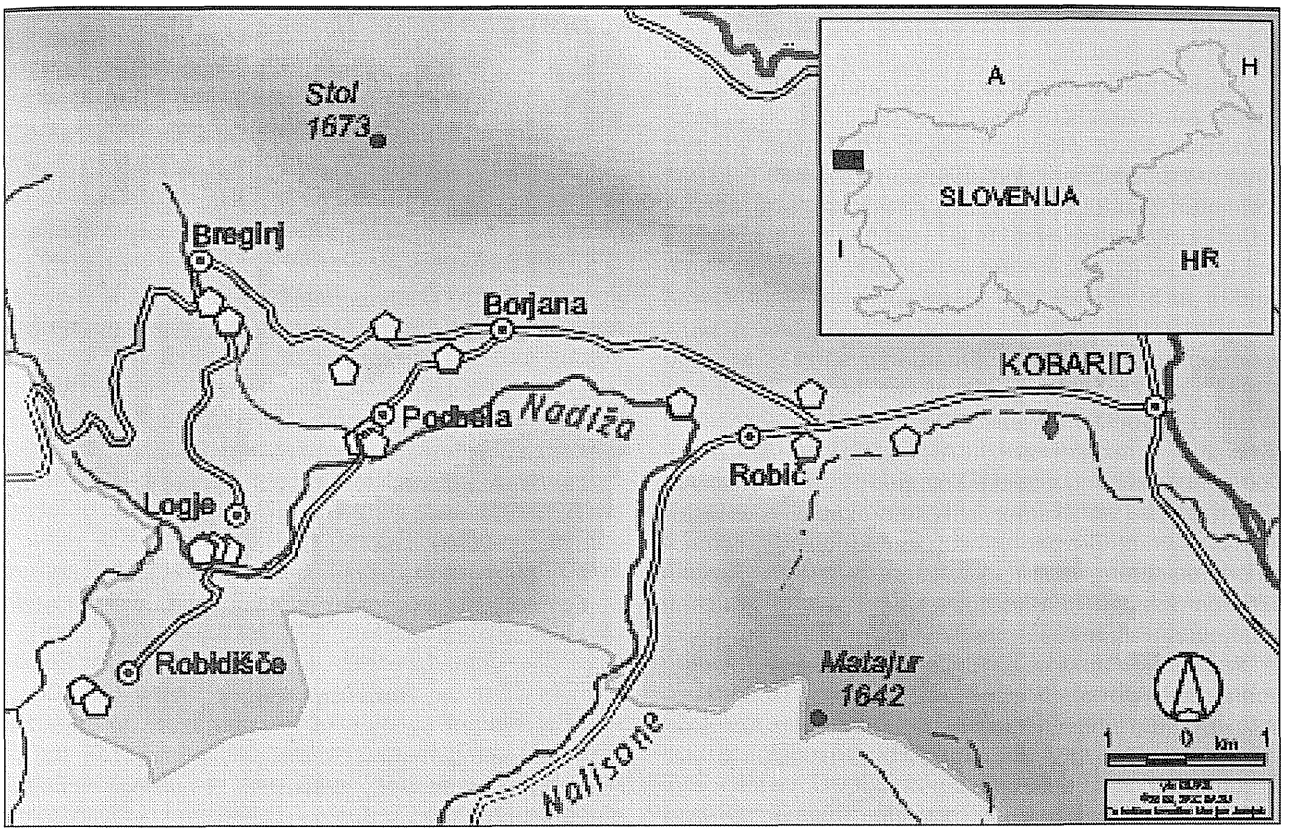
METODE

Raziskovano območje

Breginjski kot je najzahodnejši del Slovenije (Sl. 1) in ga po M. Wraberju (1969) uvrščamo še v alpsko fitogeografsko območje, po Zupančiču in sodelavcih (1987) pa v submediteransko-predalpski distrikt predalpskega podsektorja alpskega sektorja ilirske florne province. Raziskano območje ima humidno podnebje. Povprečna količina padavin v obdobju 1931-1969 je bila 2725 mm (Pučnik, 1980), v obdobju 1961-1990 pa nekoliko manj, 2593 mm (Zupančič, 1995). Temperaturnih postaj v Breginjskem kotu ni, najbližji sta v sosednji Benečiji. V vasi Matajur (Montemaggiore, 954 m) so namerili povprečno letno temperaturo 9,2°C, v vasi Njivice (Vedronza, 320 m) pa 10,1°C (M. Wraber, 1965). Iz teh podatkov Lovrenčak & Plut (1978) sklepata, da v tem območju glede temperaturnih razmer prevladuje mediteranski vpliv nad alpskim. Geološka sestava Breginjskega kota je precej pisana. V zgornjem montanskem in subalpinskem pasu prevladujejo karbonatne kamnine (triasni in jurski apnenci ter dolomit). Nižji predeli v submontanskem in spodnjem montanskem pasu, kjer so naselja, so večinoma iz krednega fliša in ledeniške morene. Ob reki Nadiži so aluvialne prodnate terase (glej tudi Buser, 1986, 1987).

Terensko vzorčenje

Fitocenološke popise smo naredili poleti 2001. Kljub že zelo redkim njivam nam je uspelo najti 19 primernih popisnih ploskev, in sicer večinoma na njivah krompirja, saj so koruzne njive izredno redke. Vegetacijo smo preučevali po standardni srednjeevropski metodi



Sl. 1: Raziskovano območje.
Fig. 1: Study area.

(Braun-Blanquet, 1964; Westhoff & van der Maarel, 1973). Pri delitvi asociacije na nižje enote smo uporabili načelo večrazsežne členitve vegetacijskih enot (Matuszkiewicz & Matuszkiewicz, 1981).

Statistične analize

Numerične analize smo naredili z računalniškima programoma SYN-TAX 2000 (Podani, 2001) in CANOCO (ter Braak & Šmilauer, 1999). Kot pripomoček za opis ekoloških razmer smo uporabili indikacijske vrednosti po Ellenbergu in sodelavcih (1991). Izračun Ellenbergovih vrednosti smo opravili s programom JUICE 5.1 (Tichý, 2001). Kombinirane ocene zastiranja in pogostnosti smo pretvorili kot predlaga van der Maarel (1979).

Sintaksonomska nomenklatura je v skladu z delom Mucina in sodelavcev (1993), nomenklaturo praprotnic in semenk navajamo po Martinčiču in sodelavcih (1999) razen vrst: *Centaurea nigrescens* Willd., *C. weldeniana* Rchb., *Nicandra physaloides* (L.) Gaertn.

REZULTATI IN DISKUSIJA

V sintetski tabeli (Tab. 2) smo primerjali raziskovane sestoje z že zbranimi iz literature s sosednjih območij. Primerjali smo jih z asociacijami *Panico-Chenopodietum* (Seljak, 1989), *Echinochloo-Setarietum* (Seljak, 1989; Poldini *et al.*, 1998) in *Galeopsido-Galinsogetum* Poldini *et al.* 1998.

Vse tri asociacije so floristično sorodne raziskovanim sestojem, a so ti najbolj podobni sestojem, ki jih uvrščamo v asociacijo *Echinochloo-Setarietum*.

Od sestojev, ki jih uvrščamo v asociacijo *Panico-Chenopodietum polyspermi*, jih razlikujejo vrste: *Chenopodium polyspermum*, *Polygonum lapathifolium* in *Cerastium glomeratum*.

Že Poldini in sodelavci (1998) menijo, da je floristična sorodnost asociacij *Galeopsido-Galinsogetum* in *Echinochloo-Setarietum* velika. V sestojih asociacije *Galeopsido-Galinsogetum* ni vrst iz poddružine *Panicoideae* (s C4 fotosintezo), ki pa jih najdemo v raziskovanih sestojih.

Sinsistematska uvrstitev

Sinsistematska uvrstitev raziskovanih sestojev je težavna zaradi različne interpretacije asociacij *Echinochloo-Setarietum pumile* Felföldy 1942 corr. Mucina 1993 in *Panico-Chenopodietum polyspermi* R. Tx. 1937 v literaturi. Zaradi njune velike sorodnosti in težavnosti razločevanja sestojev, ki je posledica intenzivnega kmetovanja, ju nekateri avtorji združujejo (Topić, 1982; Poldini *et al.*, 1998). Ob tem pa številni avtorji jasno ločujejo sestoje, kjer se pojavlja *Chenopodium polyspermum* (Seljak, 1989; Oberdorfer, 1993; Mucina, 1993; Lešnik, 1995; Jarolímek *et al.*, 1997) in jih uvrščajo v asociacijo *Panico-Chenopodietum*. Asociaciji uvrščamo v različni zvezi. Asociacijo *Panico-Chenopodietum* uvrščamo v zvezo *Spergulo-Oxalidion* Görs in Oberd. *et al.* 1967, kamor uvrščamo okopavinske sestoje na vlažnih, ilovnatih rastiščih. Asociacijo *Echinochloo-Setarietum pumile* uvrščamo v zvezo *Panico-Setarion* Sissingh in Westhoff *et al.* 1946, ki združuje sestoje na suhih in toplih rastiščih.

Asociacijo *Panico-Chenopodietum* razlikujejo vlagoljubne vrste razreda *Bidentetea* (Oberdorfer, 1993). Krippelová (1981) omenja vrste razredov *Molinio-Arrhenatheretea* oz. *Phragmitetea*, ki prav tako nakazujejo vlagoljubnost.

Pott (1995) omenja vrste *Mentha arvensis, Rorippa palustris* in *Lythrum salicaria* kot razlikovalne vrste asociacije *Panico-Chenopodietum*. Pojavljanje trav, odpornih proti herbicidom, nakazuje prehod k združbam zveze *Digitario-Setarion*.

V raziskovanih sestojih v Breginjskem kotu se pojavlja tudi vrsta *Chenopodium polyspermum*, ki pa v njih ne dominira. Asociacija *Panico-Chenopodietum* se pojavlja na poplavljenih tleh oziroma rastiščih s stoječo vodo (Pott, 1995), česar v Breginjskem kotu ni. Rast nekaterih vlagoljubnih vrst lahko pojasnimo z izdatno količino padavin in antropogenim vplivom (zalivanje vrtov), kar povečuje humidnost združbe.

To je bil tudi razlog za našo odločitev, da bomo preučevane sestoje uvrstili v asociacijo *Echinochloo-Setarietum pumile*.

Diagnostično kombinacijo vrst asociacije sestavljajo *Echinochloa crus-galli, Galinsoga parviflora, Amaranthus retroflexus, Chenopodium album, Cirsium arvense, Fallopia convolvolus* in *Setaria pumila* (Jarolímek *et al.*, 1997).

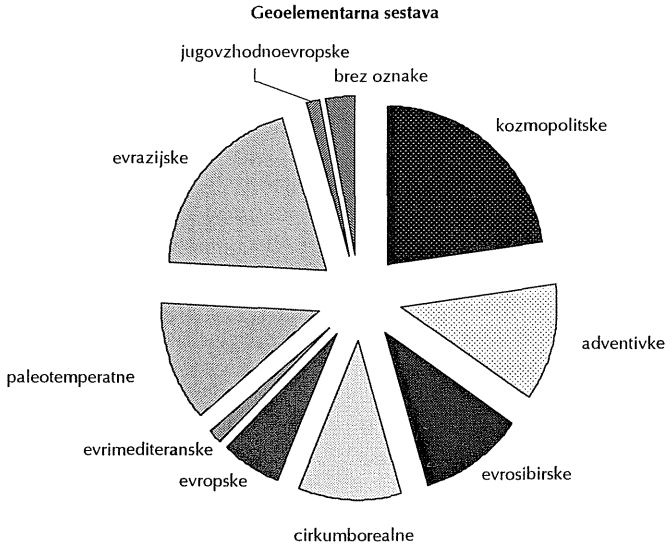
Uvrstitev v zvezo *Panico-Setarion* potrjuje pojavljanje številnih vrst iz poddružine *Panicoideae*. Sinsistematska uvrstitev sestojev je naslednja:

Stellarietea mediae R. Tx. Lohmeyer et Preising in R. Tx. 1950,
Chenopodietalia albi R. Tx. (1937) 1950,
Panico-Setarion Sissingh in Westhoff *et al.* 1946,
Echinochloo-Setarietum pumilae Felföldy 1942 corr. Mucina 1993.

Floristična sestava

V sestojih dominira *Galinsoga parviflora*, ki pa jo ponekod popolnoma nadomesti *Galinsoga ciliata*. Kodominantna vrsta je *Setaria pumila*.

Značilni videz sestojem dajejo še vrste *Chenopodium album, Echinochloa crus-galli, Polygonum persicaria, Stellaria media, Digitaria sanguinalis*. Pogoste, a z manjšo pokrovnostjo, so še vrste: *Capsella bursa-pastoris, Lamium purpureum, Convolvolus arvensis* in *Taraxacum officinale*. Horološki spekter (po Poldiniju, 1991) nakazuje srednjeevropski značaj asociacije (Sl. 2).



Sl. 2: Horološki spekter asociacije *Echinochloo-Setarietum pumilae.*
Fig. 2: Chorological spectrum of the association *Echinochloo-Setarietum pumilae.*

Členitev na nižje sinsistematske enote in njihova ekologija

Poldini in sodelavci (1998) so s številnimi popisi preučili plevelno vegetacijo sosednje Furlanije-Julijske krajine, zato smo se odločili, da upoštevamo njihovo členitev. Avtorji obravnavajo popise iz Furlanije-Julijske krajine kot posebno geografsko različico v Evropi splošno razširjene asociacije *Echinochloo-Setarietum*. Jugovzhodnoalpsko raso razlikujejo vrste *Polygonum persicaria, Euphorbia helioscopia, Chenopodium polyspermum* in *Calystegia sepium*, ki se pojavljajo tudi v naših popisih.

Raso členijo na dve podrasi: kraško in julijsko. V tabeli ni posebej izpostavljena subasociacija, vendar lahko sklepamo, da gre za tipično, saj nato avtorji oddelijo še subasociacijo *xanthietosum*. Podrasi nato Poldini in sodelavci (1998) delijo na toplo in hladno varianto. Zadnjo dobro označijo razlikovalnice *Galinsoga parviflora, Stellaria media, Lamium purpureum, Fallopia convolvolus* in *Trifolium pratense*, tako da lahko sestoje iz Breginjskega kota uvrstimo v hladno različico.

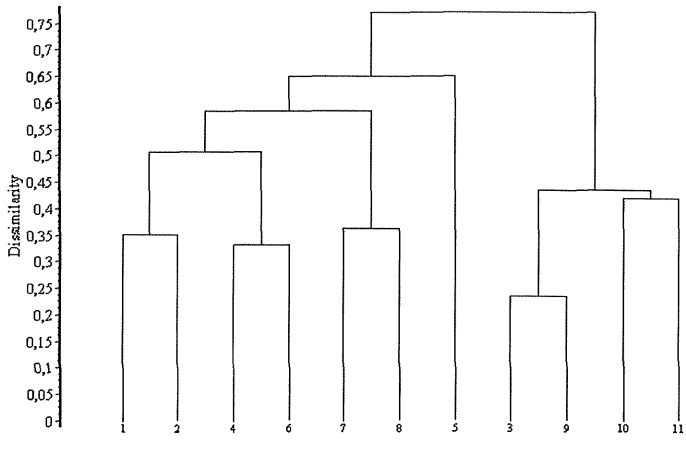
Znotraj raziskovanih sestojev smo ugotovili višinsko variabilnost, zato smo se odločili, da ločimo višinsko formo, ki jo kot razlikovalnica označuje vrsta *Galeopsis tetrahit*. Najdemo jo na nadmorski višini od 550 do 680 metrov. Razlikovalnica *Galeopsis tetrahit* nakazuje humidno klimo, predvsem v montanskem svetu (Hofmeister & Garve, 1998). Holzner (1973) jo označi kot značilno vrsto višjih leg, ki uspeva na tleh z različno reakcijo tal. Podobno členitev podaja Oberdorfer (1993) za asociacijo *Panico-Chenopodietum*.

Sestoji forme *Galeopsis tetrahit* kažejo veliko podobnost z asociacijo *Galeopsido-Galinsogetum* Poldini *et al.* 1998.

V dendrogramu (Sl. 3) se kot poseben šop ločijo sestoji *Echinochloo-Setarietum*-julijska podrasa, hladna različica (Poldini *et al.*, 1998), *Echinochloo-Setarietum*-julijska podrasa, hladna različica (Čušin & Šilc, *hoc loco), Echinochloo-Setarietum*-julijska podrasa, hladna različica, forma *Galeopsis tetrahit* (Čušin & Šilc, *hoc loco)* in *Galeopsido-Galinsogetum* (Poldini *et al.*, 1998).

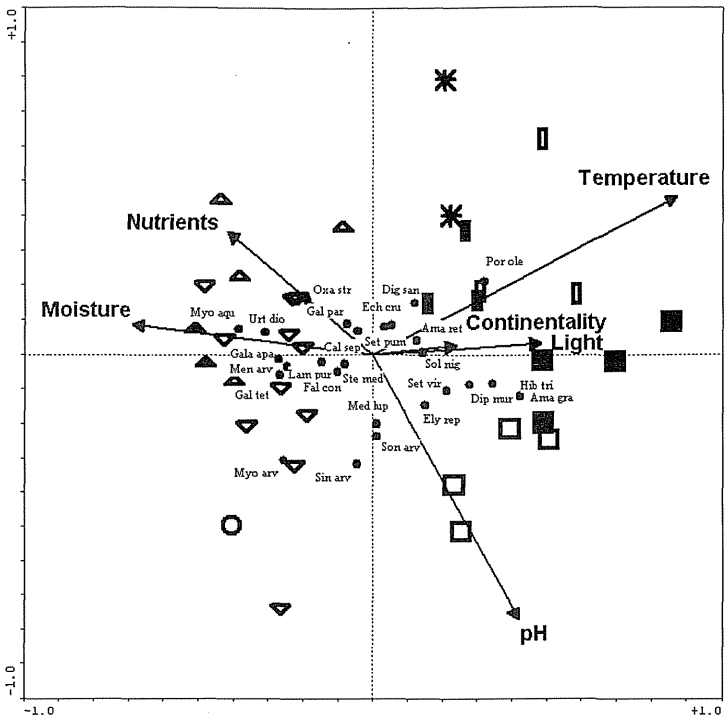
Sestoji hladne različice uspevajo na dnu predalpskih dolin in v gričevju Furlanije-Julijske krajine, na nadmorski višini med 150 in 400 m (Poldini *et al.*, 1998). Enako velja za sestoje v Breginjskem kotu.

V sestojih v Breginjskem kotu najdemo tudi razlikovalne vrste asociacije *Galeopsido-Galinsogetum*, ki uspeva v višjih nadmorskih legah. Vzrok za pojavljanje teh razlikovalnih vrst je nadmorska višina, velika količina padavin, majhna površina obdelovalnih površin in organsko gnojenje. Za sestoje asociacije *Galeopsido-Galinsogetum* kot tudi za njive v Kotu je značilno, da so v bližini naselij, niso škropljene s herbicidi in so ročno obdelane (Poldini, *ustno).* Večinoma sadijo krompir in fižol, koruza je redka, medtem ko je v primeru asociacije *Echinochloo-Setarietum*, ki so jo popisali Poldini in sodelavci (1998), koruza prevladujoča kultura. Kot smo že omenili v sestojih asociacije *Galeopsido-Galinsogetum*, manjkajo vrste poddružine *Panicoideae* (s C4 fotosintezo), ki pa jih najdemo v sestojih višinske forme in jih zato ne moremo uvrstiti v asociacijo *Galeopsido-Galinsogetum*.



Sl. 3: Primerjava različnih oblik asociacij *Panico-Chenopodietum, Echinochloo-Setarietum* ***in*** *Galeopsido-Galinsogetum* ***(frekvenca v odstotkih, popolno povezovanje, koeficient podobnosti). Številke ponazarjajo stolpce v sintetski tabeli (Tab. 2).***

Fig. 3: Comparison of various forms of the associations *Panico-Chenopodietum, Echinochloo-Setarietum* ***and*** *Galeopsido-Galinsogetum* ***(frequency in percentage, complete link, similarity ratio). Numbers refer to columns in the synthetic table (Tab. 2).***



Sl. 4: CCA ordinacija. Legenda: ▯- *Echinochloo-Setarietum* ***kraška (goriška) podrasa,*** ✱- *Echinochloo-Setarietum* ***julijska podrasa hladna varianta,*** ■- *Echinochloo-Setarietum* ***kraška podrasa topla različica,*** □- *Echinochloo-Setarietum* ***kraška podrasa hladna različica,*** ▽- *Galeopsido-Galinsogetum,* ▲- *Echinochloo-Setarietum* ***julijska podrasa hladna različica (Breginjski kot),*** ▲- *Echinochloo-Setarietum* ***forma*** *Galeopsis tetrahit,* ▮- *Echinochloo-Setarietum* ***julijska podrasa topla različica,*** ○- *Panico-Chenopodietum.*

Fig. 4: CCA ordination. Legend: ▯- *Echinochloo-Setarietum* ***Karst subrace,*** ✱- *Echinochloo-Setarietum* ***Friuli subrace cool variant,*** ■- *Echinochloo-Setarietum* ***Karst subrace warm variant,*** □- *Echinochloo-Setarietum* ***Karst subrace cool variant,*** ▽- *Galeopsido-Galinsogetum,* ▲- *Echinochloo-Setarietum* ***Friuli subrace cool variant (Breginjski kot),*** ▲- *Echinochloo-Setarietum* ***forma*** *Galeopsis tetrahit,* ▮- *Echinochloo-Setarietum* ***Friuli subrace warm variant,*** ○- *Panico-Chenopodietum.*

V grafu (Sl. 4), ki smo ga dobili z metodo CCA, je prikazana neposredna gradientna analiza sintetske tabele (Tab. 2). Rastiščne razmere smo prikazali z Ellenbergovimi vrednostmi (netehtano povprečje za posamezni popis), za kar smo uporabili program JUICE 5.1. V grafu so zaradi boljše preglednosti prikazane le nekatere vrste in popisi (minimum fit 10). V smeri gradienta vlažnosti in hranil se združujejo popisi sintaksonov: *Galeopsido-Galinsogetum* (Poldini *et al.*, 1998), *Echinochloo-Setarietum* julijska podrasa hladna različica (Poldini *et al.*, 1998; Čušin & Šilc, *hoc loco)* in *Panico-Chenopodietum* (Seljak, 1989). V smeri naraščanja svetlo- in toploljubnosti se združujejo popisi asociacije *Echinochloo-Setarietum* s Krasa, Goriške in tople različice julijske podrase.

ZAHVALA

Za popravke in nasvete pri pisanju se zahvaljujeva dr. I. Dakskoblerju in dr. A. Čarniju. Za komentar fitocenološke tabele se zahvaljujeva prof. dr. L. Poldiniju, za izdelavo karte pa M. Jarnjaku.

Tab. 1: *Echinochloo-Setarietum pumile* ***Felföldy 1942 corr. Mucina 1993.***

Tab. 1: *Echinochloo-Setarietum pumile* ***Felföldy 1942 corr. Mucina 1993.***

																			prezen-ca	frek-venca
	Popisna ploskev-Relevé area (m²)	100	50	50	40	100	50	60	100	100	80	40	80	50	50	150	100	40	60	100		
	Nadmorska višina-Altitude (m)	305	300	295	300	500	380	240	250	500	240	250	500	500	500	550	681	551	600	670		
	Pokrovnost zeliščne plasti-Cover (%)	80	100	50	90	80	80	100	100	40	90	90	100	90	90	100	80	90	90	60		
	Število vrst- Number of species	22	22	21	17	19	17	18	8	24	24	22	19	22	30	24	20	29	22	18		
	Diagnostična kombinacija Diagnostic combination																					
	Chenopodium album	1	2	1	+	+	+	+	+	+	+	1	+	2	1	1	+	2	1	1	19	100
DV	Galinsoga parviflora	2	+	4	5	3	4	.	1	2	3	.	+	1	3	5	5	3	5	3	17	89
	Echinochloa crus-galli	+	+	+	+	1	.	+	+	.	+	.	1	+	1	+	+	1	+	+	16	84
	Setaria pumila	1	2	2	2	+	1	1	.	.	1	1	+	.	+	1	.	+	1	.	14	74
DV	Fallopia convolvulus	1	1	.	+	.	+	.	.	.	.	+	.	+	.	2	.	+	+	.	9	47
	Amaranthus retroflexus	+	2	.	+	.	.	1	.	.	+	+	.	.	.	.	.	.	.	.	6	32
	Cirsium arvense	.	+	1	.	.	.	.	.	+	.	.	.	.	.	+	.	+	.	+	6	32
	Razlikovalnica višinske forme Differential species of the altitudinal form																					
DF	Galeopsis tetrahit	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	1	+	1	4	21
	Stellarietea mediae																					
DR	Polygonum persicaria	2	1	1	1	+	1	+	+	1	+	1	1	1	+	1	1	+	4	1	19	100
DV	*Stellaria media*	1	.	2	1	2	1	.	.	2	3	.	1	1	1	+	2	2	1	2	15	79
	Capsella bursa-pastoris	+	.	+	.	+	+	.	.	+	+	.	+	+	+	+	1	+	+	+	14	74
DV	Lamium purpureum	+	+	+	.	+	.	+	.	+	+	.	+	+	1	.	+	1	.	1	13	68
	Digitaria sanguinalis	+	+	2	.	+	.	1	.	+	.	+	2	+	+	.	.	2	.	.	11	58
	Veronica persica	+	.	.	.	+	.	+	.	+	+	+	.	.	+	.	+	1	+	.	10	53
	Mentha arvensis	.	.	.	1	1	2	.	.	+	.	.	.	+	1	1	+	1	+	.	10	53
DR	Euphorbia helioscopia	+	.	1	.	.	+	.	.	+	.	+	+	.	+	.	.	+	+	.	9	47
	Oxalis fontana	.	+	.	.	+	1	+	+	.	.	+	.	2	.	1	.	+	.	.	9	47
	Galinsoga ciliata	3	.	.	.	.	2	5	5	.	2	4	5	.	+	.	.	.	.	.	8	42
DR	Chenopodium polyspermum	.	.	.	.	.	.	.	.	.	+	+	+	+	1	.	+	1	.	.	7	37
	Sonchus asper	.	.	.	.	.	.	.	.	.	+	+	.	+	+	.	r	+	.	.	6	32
	Aethusa cynapium	.	1	.	.	.	.	.	.	.	.	.	1	1	.	1	.	.	1	.	5	26
	Stachys palustris	.	.	.	2	+	.	.	.	.	.	.	.	.	+	+	+	.	.	.	5	26
	Sonchus oleraceus	+	.	+	+	.	.	.	.	+	.	.	.	.	1	.	.	.	.	.	5	26
	Chamomilla recutita	.	.	.	.	+	.	.	.	.	.	.	.	r	1	.	.	.	.	.	3	16
	Geranium columbinum	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	3	16
	Setaria viridis	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	+	.	3	16
	Solanum nigrum	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	2	11
	Sorghum halepense	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Conyza canadensis	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Veronica agrestis	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Geranium molle	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	1	5
	Artemisietea																					
	Convolvulus arvensis	+	+	+	+	2	+	+	.	+	2	.	1	+	+	.	.	+	.	.	13	68
	Silene latifolia ssp. alba	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	2	11
	Silene dioica	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	2	11
	Erigeron annuus	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	2	11
	Elytrigia repens	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	2	11
	Malva mauritiana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	1	5
	Galio-Urticetea																					
DR	Calystegia sepium	1	2	1	+	1	1	2	3	+	.	2	1	2	2	+	+	+	1	1	18	95
	Galium aparine	.	+	.	.	+	.	.	.	+	.	.	.	.	+	+	.	+	.	.	6	32
	Myosoton aquaticum	.	.	.	.	.	.	.	+	+	+	.	.	.	+	.	+	.	.	+	6	32
	Urtica dioica	.	.	.	.	.	.	.	.	+	.	.	.	.	+	+	.	+	.	+	5	26
	Glechoma hederacea	.	.	.	.	.	+	.	.	+	+	.	.	.	.	.	.	.	.	.	3	16
	Lamium album	.	.	.	.	.	.	+	.	.	+	.	.	.	.	+	.	.	.	.	3	16
	Aegopodium podagraria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	5
	Molinio-Arrhenatheretea																					
	Taraxacum officinale	1	+	+	+	.	+	+	.	+	1	+	+	.	+	.	+	+	+	+	15	79
	Rumex obtusifolius	+	.	.	.	.	.	.	.	+	.	+	.	.	+	+	+	+	+	1	9	47
	Ranunculus repens	.	+	+	.	.	.	+	.	+	.	+	.	.	+	.	1	+	.	1	9	47
	Trifolium repens	.	.	.	+	.	.	+	.	.	+	.	.	+	+	.	.	.	+	+	7	37
DV	Trifolium pratense	+	.	.	.	.	.	.	.	.	+	+	.	.	.	+	.	.	.	.	4	21
	Medicago lupulina	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	+	+	.	4	21
	Achillea millefolium agg.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	2	11
	Vicia cracca	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Ranunculus acris	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	1	5
	Potentilla reptans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	1	5
	Ostale / Other species																					
	Armoracia rusticana	.	+	+	+	.	.	+	.	.	+	.	+	.	.	.	.	.	.	.	6	32
	Amaranthus lividus	.	.	.	.	+	.	.	.	+	+	+	.	.	.	.	+	.	.	+	6	32
	Equisetum arvense	.	1	.	+	+	.	.	.	+	+	.	.	.	.	.	.	.	.	.	5	26
	Poa annua	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	+	.	.	+	4	21
	Petasites hybridus	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	1	5
	Bidens tripartita	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	1	5
	Plantago major ssp. intermedia	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	5
	Polygonum aviculare agg.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	5
	Commelina communis	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	1	5
	Papaver somniferum	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Pimpinella anisum	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Polygonum mite	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	1	5

DR- razlikovalna vrsta geografske variante (differential species of the geographical variant)
DV- razlikovalna vrsta variante (differential species of the variant)
DF- razlikovalna vrsta forme (differential species of the altitudinal form)

Tab. 2: Sintetska tabela okopavinskih združb v Zahodni Sloveniji in Furlaniji-Julijski krajini.
Tab. 2: Synoptic table of hoe weed communities in western Slovenia and Friuli-Venezia Giulia (NE Italy).

	Fitocenoza (Phytocoenosis)	1	2	3	4	5	6	7	8	9	10	11
	Število popisov (Number of relevés)	14	17	16	7	5	17	6	12	15	4	23
	Panico-Chenopodietum (Dass.1)											
DR, Dass.1	Chenopodium polyspermum	93	12	62	14	40	6		50	33	50	30
DS, Dass.1	Bidens tripartita	36	18		14	100	6			7		39
Dass.1	Oxalis fontana	14		6		20	12			53	25	4
Dass.1	Rorippa sylvestris	14	24	6					8			
DS, Dass.1	Polygonum lapathifolium	71	29		43	100						
	Cerastium glomeratum	29										
	Echinochloo-Setarietum (Dass.2)											
DR, Dass.2	Calystegia sepium	50	41	88	57	100	88	33	42	93	100	65
Dass.2	Amaranthus retroflexus	64	71	88	100	100	88	83	100	40		
Dass.2	Solanum nigrum	29	24	31	86	60	76	83	67	13		
Cass.2	Portulaca oleracea	14	24	19	71		6	33	8			
	var. geogr. Calystegia sepium (DR)											
DR	Euphorbia helioscopia	57	35	75	43	60	59	50	83	47	50	65
DR	Polygonum persicaria	71	59	81	100		88	33	83	100	100	96
	subvar. geogr. Kras (DSR1)											
DSR1	Veronica persica	64	100	44	29	20	24	83	58	47	75	26
DSR1	Elytrigia repens	14	12	12	14	40	24	67	75	13		4
DSR1	Cirsium arvense	14	41	12	29		12	67	58	27	50	43
DSR1	Setaria viridis	14	18				18	67	42	13	25	26
DSR1	Diplotaxis muralis	7	41	6				83	42			
DSR1	Amaranthus graecizans	7	6		14			67	50			
DSR1	Erodium cicutarium		6					33	17			
DSR1	Trifolium incarnatum ssp. molineri							17	25			
	subass. typicum **hladna varianta (DV1)** cold variant											
DV1	Fallopia convolvulus	14	6	38	14		6	33	83	47	50	83
DV1	Stellaria media	93	88	56			18	33	67	73	100	96
DV1	Lamium purpureum	14	29	44			12		33	67	75	57
DV1	Trifolium pratense	7	6	25				33	42	27		17
	topla varianta & agroforma (DV2) warm variant & agroform											
DV2	Sorghum halepense		12	6	57	40	59	17	8	7		
DV2	Hibiscus trionum				14	40	6	100	17			
	subass. xanthietosum (DS1)											
DS1	Xanthium italicum				14	80						
DS1	Bidens frondosa			6		60						
DS1	Lycopus europaeus					40						
	Galeopsido-Galinsogetum (Dass.3)											
DV1, Dass.3	Galinsoga parviflora		100	100	29		65		42	87	100	74
DSR1, Dass.3	Stachys palustris	7	18						25	27	25	39
Dass.3	Mentha arvensis		12							47	75	39
Dass.3	Galinsoga ciliata			12			6			53		26
Dass.3	Aethusa cynapium									27	25	30
Dass.3	Galium aparine									33	25	70
DF, Dass.3	Galeopsis tetrahit										100	65
Dass.3	Galeopsis speciosa											48
	Stellarietea mediae											
	Echinochloa crus-galli	86	76	88	100	100	24	33	42	80	100	13
	Digitaria sanguinalis	36	41	75	86	40	76	100	25	67	25	4
	Setaria pumila	50	53	100	43	100	53	83	50	80	50	48
	Chenopodium album	79	100	100	100	100	71	100	92	100	100	100
	Capsella bursa-pastoris	57	65	81	14		47	17	83	67	100	74
	Sonchus oleraceus	57	35	62	43	60	24	67	58	33		74
	Sonchus asper	43	29	19	14	60	12		50	27	50	
	Senecio vulgaris	50	29		29	20	29	33	42			
	Conyza canadensis	21		6		20	6	17	8	7		
	Mercurialis annua	29	41	6			47		42			4
	Vicia sativa agg.	14				20	6	17	17			4
	Cynodon dactylon	14	6	6			35	17				
	Anagallis arvensis	29	12	6	14				17			
	Sinapis arvensis	50					6	33	33			9
	Geranium molle						6	17	17	7		4
	Diplotaxis tenuifolia			6	14	20	6	33				
	Geranium columbinum	14								7	50	13

Fitocenoza (Phytocoenosis)	1	2	3	4	5	6	7	8	9	10	11
Število popisov (Number of relevés)	14	17	16	7	5	17	6	12	15	4	23
Panicum miliaceum							17	8			4
Lamium amplexicaule	7	6						8			
Heliotropium europaeum		6				6		8			
Amaranthus lividus	7								27	50	
Geranium pusillum							17	17			4
Brassica napus						6		8			9
Cardamine hirsuta			6			6					4
Vicia sepium			12			12					4
Datura stramonium					40	24		8			
Amaranthus cruentus	7	24									
Amaranthus hybridus	29	71									
Lactuca serriola	7	6									
Chenopodium ficifolium	14	6									
Lolium multiflorum								8			4
Oxalis corniculata			12								4
Viola tricolor			6					8			
Acalypha virginica			6	14							
Bromus sterilis	7	6									
Chamomilla recutita									20		9
Fumaria officinalis	21										
Raphanus raphanistrum ssp. landra	14										
Atriplex patula	7										
Myosotis arvensis											26
Sherardia arvensis											4
Atriplex tatarica											4
Veronica hederifolia											4
Vicia hirsuta											4
Euphorbia peplus			6								
Abutilon theophrasti					20						
Brassica nigra						6					
Stachys annua								8			
Veronica agrestis									7		
Borago officinalis											4
Euphorbia falcata								8			
Misopates orontium								8			
Nicandra physalodes							17				
Papaver somniferum									7		
Phalaris canariensis											4
Artemisietea											
Convolvulus arvensis	43	35	25	14		53	100	83	80	25	74
Erigeron annuus	7	18	31	57	60	24			7	25	17
Artemisia vulgaris		6	6	43		18		8			4
Daucus carota		6	12		20	12	17				13
Mentha spicata				14	20	12	17	8			
Verbena officinalis			6	14	40			8			
Silene vulgaris			12					8			4
Cichorium intybus	14			14							
Silene latifolia ssp. alba									13		9
Cirsium vulgare			6			6					
Lamium album									20		9
Malva neglecta											4
Picris hieracioides						6					
Picris echioides						6					
Medicago sativa								8			
Malva sylvestris var. mauritiana										25	
Silene dioica									13		
Chondrilla juncea							17				
Geranium pyrenaicum											4
Myosotis sylvatica											4
Nepeta cataria											9
Galio-Urticetea											
Aegopodium podagraria	7					6			7		13
Urtica dioica									20	50	9
Glechoma hederacea			12						20		9
Myosoton aquaticum									27	50	9
Aristolochia clematitis	7						17	8			
Helianthus tuberosus	7					6					
Rubus caesius				14		12					
Lamium maculatum											4
Sambucus ebulus						6					
Petasites hybridus									7		
Molinio-Arrhenateretea											
Taraxacum officinale agg.	50	41	62	57	60	18	67	67	73	100	26
Ranunculus repens	21	12	38		20	29	17	17	40	75	22

Fitocenoza (Phytocoenosis)	1	2	3	4	5	6	7	8	9	10	11
Število popisov (Number of relevés)	14	17	16	7	5	17	6	12	15	4	23
Trifolium repens	21	12	31	14		6			33	50	17
Medicago lupulina	36	6	19			12	17	25	13	50	
Rumex obtusifolius	43	18				12		17	33	100	4
Rumex crispus	21	12	19			6	17	17			
Potentilla reptans	7			14		12	17	8		25	
Sonchus arvensis	14	18	6					50			13
Agrostis stolonifera	14	6	12				17				
Plantago lanceolata			6				33	8			
Lythrum salicaria				14	20	6					
Poa trivialis	14	12									
Mentha longifolia		6		14							
Leucanthemum praecox							17				9
Ranunculus acris									7		4
Galium mollugo							17				4
Prunella vulgaris							17				4
Vicia cracca						6			7		
Achillea millefolium agg.							17		13		
Lolium perenne		18									
Symphytum officinale	14										
Pastinaca sativa	7										
Lathyrus pratensis											4
Dactylis glomerata											4
Arrhenatherum elatius											4
Lotus corniculatus											4
Centaurea nigrescens											4
Holcus lanatus											4
Crepis capillaris											4
Lysimachia nummularia						6					
Ranunculus sardous	7										
Ostale											
Other											
Polygonum aviculare agg.	57	24	25	14	60	24		58		25	9
Equisetum arvense	21	35	12	57	60	18		17	33		22
Poa annua		29	12						13	50	17
Plantago major	36		12		40	6		8			
Microrrhinum minus	14	6	6								
Hypericum perforatum		6				6					
Armoracia rusticana			6						40		
Arenaria serpyllifolia			6			6					
Polygonum mite					20				7		
Veronica chamaedrys											4
Commelina communis									7		
Plantago major ssp. intermedia									7		
Euphorbia lathyris											4
Galium lucidum											4
Pimpinella anisum									7		
Centaurea weldeniana							17				
Crepis rhoeadifolia							17				

Legenda (Legend):

1. Oxalido-Chenopodietum (Seljak, 1989)
2. Echinochloo-Setarietum (Seljak, 1989)
3. Echinochloo-Setarietum julijska podrasa hladna varianta (Poldini *et al.*, 1998)
4. Echinochloo-Setarietum julijska podrasa topla varianta (Poldini *et al.*, 1998)
5. Echinochloo-Setarietum julijska podrasa xanthietosum (Poldini *et al.*,1998)
6. Echinochloo-Setarietum agroforma Sorghum halepense (Poldini *et al.*, 1998)
7. Echinochloo-Setarietum kraška podrasa topla varianta (Poldini *et al.*, 1998)
8. Echinochloo-Setarietum kraška podrasa hladna varianta (Poldini *et al.*, 1998)
9. Echinochloo-Setarietum julijska podrasa hladna varianta (Čušin & Šilc, *hoc loco)*
10. Echinochloo-Setarietum julijska podrasa hladna varianta forma Galeopsis tetrahit (Čušin & Šilc, *hoc loco)*
11. Galeopsido-Galinsogetum (Poldini *et al.*,1998)

DA- razlikovalna vrsta asociacije (differential species of the association)
CA- značilna vrsta asociacije (character species of the association)
DR- razlikovalna vrsta geografske variante (differential species of the geographical variant)
DSR- razlikovalna vrsta geografske subvariante (differential species of the geographical subvariant)
DS- razlikovalna vrsta subasociacije (differential species of the subassociation)
DV- razlikovalna vrsta variante (differential species of the varinat)
DF- razlikovalna vrsta forme (differential species of the altitudinal form)

WEED VEGETATION OF HOE FIELDS IN THE BREGINJSKI KOT (WESTERN SLOVENIA)

Boško ČUŠIN
Institute of Biology, Science and Research Centre of the Slovene Academy of Sciences and Arts, Regional Research Unit Tolmin, SI-5220 Tolmin, Brunov drevored 13

Urban ŠILC
Institute of Biology, Science and Research Centre of the Slovene Academy of Sciences and Arts, SI-1000 Ljubljana, Gosposka 13

SUMMARY

In the article, the weed communities occurring in hoe fields of Breginjski kot are discussed. The stands are dominated by Galinsoga parviflora, *which is in places completely replaced by* G. ciliata. *The codominant species is* Setaria pumila.

The synsystematic classification of the studied stands is difficult due to the different interpretation of the associations Echinochloo-Setarietum pumile *Felföldy 1942 corr. Mucina 1993* (Panico-Setarion) *and* Panico-Chenopodietum polyspermi *R. Tx. 1937* (Spergulo-Oxalidion). *The association* Panico-Chenopodietum *is differentiated by hygrophilous species of the class* Bidentetea *(Oberdorfer 1993). The species* Chenopodium polyspermum *also occurs in the studied stands of Breginjski kot but does not dominate the stands. The association* Panico-Chenopodietum *occurs on flooded soil or sites with standing water (Pott, 1995), which is not the case at Breginjski kot where such sites cannot be found. Therefore it was decided to classify the studied stands into the association* Echinochloo-Setarietum pumile, *class* Stellarietea mediae. *The diagnostic species combination is composed of* Echinochloa crus-galli, Galinsoga parviflora, Amaranthus retroflexus, Chenopodium album, Cirsium arvense, Fallopia convolvolus *and* Setaria pumila *(Jarolímek* et al., *1997).*

Poldini and collaborators (1998) studied the weed vegetation of the neighbouring region of Friuli-Venezia Giulia with numerous relevés, and their subdivision was taken into consideration. Communities under consideration are classified into the southeastern-Alpine geographical variant, Julian subrace and, within it, into the cold variant. Within the studied stands, the altitude variability was recognised, which is the reason why we decided to separate the altitude form characterised by Galeopsis tetrahit *as its differential species. It is found at an altitude between 550 and 680 metres above sea level.*

Key words: weeds, *Stellarietea mediae*, Breginjski kot, Slovenia

LOKACIJE POPISOV

1. 9.8.2001, Podbela, Pod zidom, krompir, rendzina na produ, x=381423, y=5123588
2. 9.8.2001, Podbela, Mrakčeva njiva, krompir, rendzina na produ, x=381300, y=5123483
3. 9.8.2001, Podbela, Kolarjeva njiva, krompir, rendzina na produ, x=381444, y=5123465
4. 9.8.2001, Podbela, v Gošči, krompir, rendzina na produ, x=381487, y=5123445
5. 9.8.2001, Robidišče, krompir, fižol, zelje, pokarbonatna rjava tla, x=377999, y=5120195
6. 9.8.2001, Logje, krompir, fižol, distrična rjava tla na flišu, x=379317, y=5122105
7. 9.8.2001, Logje, krompir, fižol, distrična rjava tla na flišu, x=379327, y=5122132
8. 9.8.2001, Logje, pod Korindo, krompir, fižol, distrična rjava tla na flišu, x=379635, y=5122106
9. 9.8.2001, Breginj, ledeniška terasa, krompir, rendzina na moreni, x=379415, y=5125207
10. 9.8.2001, Breginj, pred Mostičarko, krompir, rendzina na moreni, x=379644, y=5124958
11. 9.8.2001, Borjana, krompir, rendzina na moreni, x=382433, y=5129900
12. 30.9.2001, Staro selo, vzhodno od vasi na severni strani ceste, krompir, evtrična rjava tla na produ, x=387026, y=5124038
13. 30.9.2001, Staro selo, pri pokopališču, fižol, evtrična rjava tla na produ, x=388195, y=5123459
14. 30.8.2001, Kred, proti Koritom, krompir in fižol, buče, evtrična rjava tla na produ, x=385339, y=5123889
15. 30.8.2001, Robič, pod Molido, krompir, evtrična rjava tla na produ, x=386926, y=5123370
16. 30.8.2001, Stanovišče, stara vas, krompir in fižol, rendzina na moreni, x=381645, y=5124891
17. 30.8.2001, Homec, krompir, rendzina na moreni, x=381129,y=5124385
18. 26.10.2001, Robidišče, pokarbonatna rjava tla, x=377833, y=5120338
19. 26.10.2001, Logje, distrična rjava tla na flišu, x=379455, y=122150

LITERATURA

Buser, S. (1986): Tolmač listov Tolmin in Videm (Udine). Osnovna geološka karta SFRJ 1:100.000. Zvezni geološki zavod, Beograd.

Buser, S. (1987): Osnovna geološka karta SFRJ. Tolmin in Videm 1:100.000. Zvezni geološki zavod, Beograd.

Braun-Blanquet, J. (1964): Pflanzensoziologie. Grundzüge der Vegetationskunde. Springer Verlag, Wien.

Ellenberg, H., Weber, H. E., Düll, R., Wirth, V., Werner, W. & D. Paulißen (1992): Zeigerwerte von Pflanzen in Mitteleuropa. Scripta Geobotanica, Erich Goltze Verlag, Göttingen.

Hofmeister, H. & E. Garve (1998): Lebensraum Acker. Parey Buchverlag, Berlin.

Holzner, W. (1973): Ackerunkrautvegetation Niederösterreichs. Mitt. bot. Arb. gem. Oberösterr., 5, (1), 1-157.

Jarolímek, I., Zaliberová, M., Mucina, L. & S. Mochnacký (1997): Rastlinné spoločenstvá Slovenska, 2. Synantropná vegetácia. Veda vydavatelstvo slovenskej akadémie vied, Bratislava.

Krippelová, T. (1981): Synanthrope Vegetation des Beckens Košická kotlina. Vegetácia ČSSR, VEDA, Verlag der Slowakischen Akademie der Wissenschaften, Bratislava.

Lešnik, M. (1995): Primerjalna analiza plevelnih združb na intenzivnih in ekstenzivno rabljenih njivah Ptujskega in Dravskega polja. Magistrsko delo, Oddelek za agronomijo, Biotehniška fakulteta, Univerza v Ljubljani. Ljubljana.

Lovrenčak, F. & D. Plut (1978): Prirodne in družbenogeografske značilnosti Breginja in okolice. Zbornik 10. zborovanja slovenskih geografov Tolmin-Bovec: 291-312.

Maarel van der, E. (1979): Transformation of cover-abundance values in phytosociology and its effects on community similarity. Vegetatio, 39, (2), 97-114.

Martinčič, A., Wraber, T., Jogan, N., Ravnik, V., Podobnik, A., Turk, B. & B. Vreš (1999): Mala flora Slovenije. Tehniška založba Slovenije, Ljubljana.

Matuszkiewicz, W. & A. Matuszkiewicz (1981): Das Prinzip der mehrdimensionalen Gliederung der Vegetationseinheiten, erlaeutet am Beispiel der Eichen-Hainbuchenwälder in Polen. Syntaxonomie- Ber. Int. Symp. int. Vereinig. Vegetationsk. Rinteln. Vaduz. 123-148.

Mucina, L. (1993): *Stellarietea mediae.* V: L. Mucina, G. Grabherr & T. Ellmauer: Pflanzengesellschaften Österreichs, Anthropogene Vegetation. Gustav Fisher Verlag, Jena, Stuttgart, New York, 110-168.

Mucina, L., Grabherr, G. & T. Ellmauer (1993): Die Pflanzengesellschaften Österreichs. Anthropogene Vegetation. Die Pflanzengesellschaften Österreichs, Gustav Fisher Verlag, Jena.

Oberdorfer, E. (1993): Wirtschaftswiesen und Unkrautgesellschaften. Süddeutsche Pflanzengesellschaften, G. Fischer Verlag, Jena, Stuttgart, New York.

Podani, J. (2001): SYN-TAX 2000. Computer programs for data analysis in ecology and systematics. Budapest.

Poldini, L. (1991): Atlante corologico delle piante vascolari nel Friuli-Venezia Giulia. Udine.

Poldini, L., Oriolo, G. & G. Mazzolini (1998): The segetal vegetation of vineyards and crop fields in Friuli-Venezia Giulia (NE Italy). Studia Geobotanica, 16, 5-32.

Pott, R. (1995): Die Pflanzengesellschaften Deutschlands. Verlag Eugen Ulmer, Stuttgart.

Pučnik, J. (1980): Velika knjiga o vremenu. Cankarjeva založba, Ljubljana.

Seljak, G. (1989): Plevelna vegetacija vinogradov in sadovnjakov na Goriškem in vpliv večletne rabe nekaterih herbicidov na spremembo dominantnosti nekaterih vrst. Magistrsko delo. Oddelek za agronomijo, Biotehniška fakulteta, Univerza v Ljubljani. Ljubljana.

ter Braak, J. F. C. & P. Šmilauer (1998): CANOCO Reference Manual and User's Guide to Canoco for Windows: Software for Canonical Community Ordination (version 4). Microcomputer Power (Ithaca, NY, USA), Ithaca, NY, USA.

Tichý, L. (2001): JUICE 5.1- software for analysis of phytosociological tables.

Topić, J. (1982): Ekološka istraživanja korovne vegetacije okopavina u kontinentalnom području Hrvatske. Doktorska disertacija. Prirodoslovno-matematički fakultet, Sveučilište u Zagrebu. Zagreb.

Westhoff, V. & E. van der Maarel (1973): The Braun-Blanquet approach. V: R. H. Whittaker: Ordination and Classification of Communities. Handbook of Vegetation Science, Dr. W. Junk Publishers, The Hague, 617-727.

Wraber, M. (1969): Pflanzengeographische Stellung und Gliederung Sloweniens. Vegetatio, 17, 1-6, 176-199.

Zupančič, B. (1995): Klimatografija Slovenije. Padavine 1961-1990. Hidrometeorološki zavod Republike Slovenije, Ljubljana.

Zupančič, M., Marinček, L., Seliškar, A. & I. Puncer (1987): Considerations on the phytogeographic division of Slovenia. Biogeographia 13: 89-98.

original scientific paper
received: 22. 5. 2002

UDC 581.5:633.2.03(497.4-18)

CONTRIBUTION TO THE KNOWLEDGE OF THE DRY GRASSLAND VEGETATION ON THE HIGHLAND AREAS OF THE POHORJE MOUNTAIN (SLOVENIA)

Mitja KALIGARIČ & Sonja ŠKORNIK

Department of Biology, Pedagogical Faculty, University of Maribor, SI-2000 Maribor, Koroška 160 and
Institute for biodiversity studies, Science and Research Centre of the Republic of Slovenia, Koper, SI-6000 Koper, Garibaldijeva 18
E-mail: mitja.kaligaric@uni-mb.si; sonja.skornik@uni-mb.si

ABSTRACT

Collected relevés from the highland areas of Pohorje had been classified within secondary Mattgrass grasslands on acid soils (alliance Nardo-Agrostion tenuis, Nardetalia *order). Due to the nearby timber-line (nevertheless not reached on Pohorje!), also sub-Alpine species from natural Mattgrass stands (alliance* Nardion strictae) *penetrates into these grasslands. The mixture of sub-Alpine species, lowland* Nardetalia *and* Arrhenatheretalia *species is characteristic of the association* Homogyno alpinae-Nardetum *Mráz 1956. Association is species-poor, rather uniform, it varies due to the rockiness and soil humidity, eutrophisation level and shading effect.*

Key words: dry grasslands, silicates, Mattgrass stands, *Nardo-Agrostion tenuis, Homogyno alpinae-Nardetum,* Pohorje, Slovenia

CONTRIBUTO ALLA CONOSCENZA DELLA VEGETAZIONE DI PASCOLI ARIDI IN CIMA ALLA MONTAGNA DEL POHORJE (SLOVENIA)

SINTESI

I rilievi raccolti nelle aree in cima al Pohorje sono stati classificati come pascoli a nardo secondari su suolo acido (alleanza Nardo-Agrostion tenuis, *ordine* Nardetalia). *A causa della prossima linea boschiva (non raggiunta, tuttavia, sul Pohorje) pure specie sub-alpine di nardetei naturali (alleanza* Nardion strictae) *sono penetrate in tali pascoli. La mescolanza di specie sub-alpine e di specie di pianura appartenenti a* Nardetalia e Arrhenatheretalia *è caratteristica dell'associazione* Homogyno alpinae-Nardetum *Mráz 1956. L'associazione è povera di specie, piuttosto uniforme e varia a seconda della rocciosità, dell'umidità del suolo, del livello di eutrofizzazione e dell'effetto ombra.*

Parole chiave: pascoli aridi, silicati, nardetei, *Nardo-Agrostion tenuis, Homogyno alpinae-Nardetum,* Pohorje, Slovenia

INTRODUCTION

It is rather interesting the fact that grassland vegetation of Pohorje, dominating mountain area in NE Slovenia, remained unexplored till the end of 20th century. There are of course also exceptions, as for example forest vegetation and vegetation of raised bogs, which were investigated thoroughly by many researches *(e.g.* M. Wraber, 1953, 1954, 1955, 1956; Piskernik & Martinčič, 1970; Cenčič, 1985; Marinček, 1987; Zupančič, 1998; Culiberg & Šercelj, 2000). Regarding grasslands dominated by *Nardus stricta,* which occur on the top areas of Pohorje and are known as Pohorje mountain plains, we have numerous floristic data, which are rich and variegated, however they have more historic values as to their time distance. They were summarised and enriched by Hayek (1908-1956 1923), while they were freshened up during the visit of T. Wraber in 1970 (Wraber, 1971).

The present contribution is based on the expert's report *"Flora and vegetation of Pohorje plains",* which was made by M. Kaligarič in 1993 (Kaligarič, 1993). Results of this report have already been summarised in the special issue of the Proteus, dedicated to Pohorje Mountains. In the year 2001 additional research of the vegetation of Matgrass grasslands were done in order to complete our knowledge about these grassland vegetation. Until now they were designated simply as "Matgrass swards", which – except that in these grasslands *Nardus stricta* could be found – does not tell much about this vegetation. Matgrass *(Nardus stricta)* is one of the commonest plants especially in the outer Alps (Ellenberg, 1996). At the same time it is one of the most successful plants on lime-deficient soils, not only at altitudes up to the alpine belt but also in the lower mountains of Europe and at all levels right down to the heathland areas on the plains. It avoids lime-rich soils because here it suffers from a disturbance in its nutrient balance and especially from an iron shortage (Gigon, 1971). In Slovenia Matgrass grasslands could be found in all altitudinal belts (from Prekmurje to sub-Alpine belts in Alpine region) as well as in all phytogeographical regions (from sub-Mediterranean to sub-Pannonian region, if we only take the longest diagonal).

The most fundamental is to distinguish between natural and semi-natural (anthropogenic) Matgrass grasslands, which could be described also by vegetation belt in which they occur. The *Nardetalia* Oberd. ex Preising 1949 order is present at altitudes up to the montane belt, while higher occurs the *Caricetalia curvulae* Br.-Bl. in Br.-Bl. et Jenny 1926 order (Ellenberg, 1996). There are several schemes used for the classification of the European Matgrass grassland vegetation. We followed the *survey of Austrian plant communities (collected work "Die Pflanzengesellschaften Österreichs.")* (Mucina *et al.*, 1993; Grabherr & Mucina, 1993), where the most important surveys of European Matgrass vegetation (Preising, 1949; Oberdorfer, 1957, 1978; Krahulec, 1985, 1988) are considered and critically reviewed. In Slovenia Matgrass swards were mentioned by Aichinger (1933) for Karavanke Alpine Range.

The objectives of the present study were to present

1. classification of the vegetation of Pohorje Matgrass grasslands; 2. description of its phytogeographical and ecological characteristics and 3. dynamic of the secondary succession after the abandonment.

METHODS

Study area

Pohorje is the most dominant mountain range in the NE Slovenia. It is situated at the south-easternmost edge of the Central (non-carbonate) Alps. It links Central Alps in the north and proceeds to the lowland sub-Pannonian region in the east (Fig. 1). The northern and the western boundaries of Pohorje Mts. are determined by Drava valley from Dravograd to Maribor and by Mislinja river, while in the east and south its limit represents the road Maribor - Slovenska Bistrica – Oplotnica – Zreče – Vitanje - Mislinja. Pohorje is therefore geographically recognizable formation, which measures 50 km in length, 30 km in width and with the area of 84.000 ha (Jež, 1995).

Two geomorphological units could be distinguished, namely (1) central plateau, which is surrounded by peaks Klopni vrh, Žigartov vrh, Veliki and Javorski vrh with altitudes about 1300 m and (2) the round ridge of the western Pohorje, which begins with Rogla and continues over Planinka, Jezerski vrh and Črni vrh to Velika Kopa and Mala Kopa in western direction (Jež, 1995). Especially the latter chain, which peaks exceed 1500 m, has its top areas covered by dry grasslands – the Matgrass swards. The main characteristic of this grassland

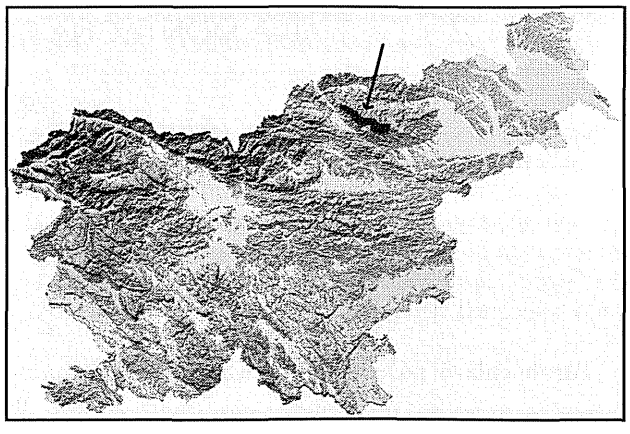


Fig. 1: Localities of the relevés of dry grasslands on the highland areas of the Pohorje Mountains.
Sl. 1: Lokalitete popisov suhih travišč na ovršnih predelih Pohorja.

vegetation is acid soil as the consequence of the non-carbonate geological bedrock. Predominating are metamorphic rocks and granodhiorythic lacolith (Hinterlechner-Ravnik, 1995). Gentle-sloping ridges are characteristic of the Pohorje Mountains as the result of the old geological formations on the top areas. Parts with bare surface and exposed rocks are only rarely to seen.

The study area has the montane climate. The average temperature in the coldest month is below –3°C and in the warmest month above 10°C. Such conditions are characteristic of altitudes between 1500 and 2000 m a.s.l.

Sampling methods and data analysis

In the years 1993 and 2001 32 phytosociological relevés of dry grassland stands on the top areas of Pohorje Mountains were collected (Fig. 1). They were compiled using standard procedure of the Braun-Blanquet approach (Braun-Blanquet, 1964; Westhoff & van der Maarel, 1973; Dierschke, 1994). All relevés were saved in the computer data base using program JODI 97 (Peterseil *et al., unpbl.).* For the classification procedure Two-Way-INdicator-SPecies ANalysis (TWINSPAN; Hill, 1979) was chosen. It was run using computer program VEGI (Reiter, 1998).

Ecological conditions of the stands were estimated by Ellenberg indicator values (Ellenberg *et al.*, 1991) for light, temperature, soil moisture, pH and nitrogen content. It should be noted that Ellenberg's N-value should be interpreted as a general indication of fertility, rather than as an index of nitrogen availability (Ellenberg *et al.*, 1991). For each relevé, indicator values were averaged over all species using species abundance as weight.

Geo-elements were determined according to Poldini (1991).

Nomenclature

Taxonomic nomenclature follows Martinčič *et al.* (1999), syntaxonomic nomenclature follows Mucina *et al.* (1993) and Grabherr & Mucina (1993).

RESULTS AND DISSCUSION

Vegetation classification

The basic dilemma, whether Matgrass swards of Pohorje belong to the natural sub-Alpine grasslands above the forest line, or to the secondary Matgrass grasslands below the forest line, seemed to be solved easily. Pohorje doesn't reach the forest line, although its top areas free from trees and with single plant species of sub-Alpine and Alpine belts have "subalpine" aspect (habitus). Some of those species belong to the class of the alpine acid-soil swards *Caricetalia curvulae.* However, their portion is too low and considering the floristic principle this relevés should be classified within the class of the Matgrass grasslands and dwarf shrub heaths *Calluno-Ulicetea,* namely to the *Nardetalia* order, which includes the lowland dry Matgrass swards. Additional confirmation of this classification is also slow but persistent spontaneous reforestation of studied Matgrass swards. Vegetation of *Nardetalia* order is spread mostly in Atlantic and sub-Atlantic Europe including Alpine region (Preising, 1949). While the lime-deficient substrates are characteristic of the larger part of the Europe where great part of the semi-natural pastures and meadows belong to that order, in Slovenia due to the prevailing calcareous bedrock, such dry pastures and meadows are not very frequent. Within *Nardetalia* order two more xerophilous alliances can be distinguished. The Matgrass swards could be therefore classified within (a) the alliance of the lowland and montane Matgrass swards *Violion caninae* Scwickerath 1944 or (b) within the alliance *Nardo-Agrostion tenuis* Sillinger 1933, which is spread mostly in the Carpathian Mountains and reaches also the edges of the Alps (Ellmauer, 1993). A central position within the *Violion caninae* has the *Polygalo-Nardetum* association. It is mainly found on very acid and nutrients poor soils from the lowland up to the altitudes about 1300 m a.s.l. and contains also sporadic alpine species (Steinbuch, 1995). Regarding bioproduction and species-richness these grasslands are richer and include more species of lowland intensive grasslands (*Arrhenatherion* alliance) than Matgrass swards of Pohorje. The latter are in general floristically poorer, but at the same time they are characterised by many species *(e.g. Gentiana pannonica, Potentilla aurea, Solidago virgaurea, Hieracium aurantiacum, Leontodon helveticus, Pseudorchis albida* and *Hypochoeris uniflora),* which do not appear in the *Polygalo-Nardetum* association. All this facts indicate that the dry grasslands from Pohorje can be assigned to the *Nardo-Agrostion tenuis* alliance, which is typical for montane belt.

Our analyses and comparisons with similar dry grassland stands from nearby Alpine region in south-eastern Austria (Steinbuch, 1995) confirmed, that within that alliance we can classify them in the association *Homogyno alpinae-Nardetum* Mráz 1956. In the study made by Steinbuch (1995) has also been reported about one high-altitude variant of the lowland association *Polygalo-Nardetum gymnadenietosum,* namely variant with the species *Homogyne alpina,* which at the higher altitudes passes directly into the *Homogyno-Nardetum* association. In such conditions it must be sometimes difficult to determine a boundary between both associations. This however is not the case in our study area: Pohorje plains are closed ecosystems, isolated on their altitudes and separated from lowland grasslands by large forests.

Relevés are presented in Tab. 1. Sequence of the relevés is according to the TWINSPAN analysis. Diag-

Tab. 1: Analytical table of the** Homogyno alpinae-Nardetum **Mráz 1956 association.
Tab. 1: Analitična tabela asociacije** Homogyno alpinae-Nardetum **Mráz 1956.

Syntaxonomical characteristic	Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32		
	Altitude (m a.s.l.)	1400	1500	1350	1540	1500	1480	1520	1450	1525	1430	1420	1520	1490	1410	1515	1480	1485	1360	1400	1490	1475	1430	1430	1465	1480	1510	1540	1400	1500	1350	1460	1400		
	Slope(°)	15	0	5	20	2	3	15	5	10	5	1	3	0	10	5	3	3	20	2	3	5	3	3	3	3	3	15	5	0	0	0	20		
	Aspect	S	/	SW	SW	S	SW	E	SW	W	W	SW	NW	/	S	NE	/	S	SW	SW	S	S	SW	SW	NW	SW	NE	W	E	/	/	/	/		
	Cover (%)	95	100	100	90	70	80	100	100	100	100	100	90	100	100	100	100	100	100	90	90	80	100	100	100	100	100	100	100	100	100	100	100		
	Plot surface (sq.m)	80	50	50	50	25	50	50	50	50	50	25	25	25	25	25	50	25	25	25	25	25	25	25	25	25	25	50	50	50	50	50	25		
	Number of species	14	16	15	13	12	14	16	16	13	13	15	22	12	18	23	18	16	21	13	15	19	15	15	13	12	19	13	15	19	26	15	25	Fr%	p
	Diagnostic species of the association																																		
	Solidago virgaurea	+	.	.	.	.	.	+	+	+	.	+	1	+	.	+	+	+	+	.	+	+	+	+	2	+	.	+	+	.	.	.	.	59	III
	Veratrum album subsp. *album*	.	.	.	.	.	.	.	+	+	+	+	.	+	.	1	.	+	+	.	.	+	+	.	+	.	+	.	+	.	.	+	.	+	50	III
VP	*Homogyne alpina*	.	.	+	.	.	2	+	+	.	+	.	2	2	1	2	.	.	.	1	.	.	.	.	1	.	+	.	+	.	+	+	.	.	47	III
CC	*Hypochoeris uniflora*	.	+	+	+	.	.	+	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	25	II
CC	*Gentiana pannonica*	.	.	.	.	.	+	.	.	+	.	.	+	.	+	.	+	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	22	II
CC	*Potentilla aurea*	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	I
A,O	***Nardo-Agrostion tenuis* Sillinger 1933, *Nardetalia* Oberd. ex Preising 1949**																																		
	Nardus stricta	3	2	1	1	+	1	4	5	5	3	4	3	3	3	2	3	3	2	4	3	3	3	4	3	4	4	5	3	2	4	4	3	100	V
	Arnica montana	+	+	+	1	+	+	1	1	1	1	+	1	+	+	1	+	1	2	1	3	2	+	+	1	2	2	1	+	+	1	.	2	97	V
	Hieracium aurantiacum	.	.	+	.	.	.	.	+	.	.	.	+	.	+	+	.	.	.	.	.	.	+	+	.	.	.	.	.	+	+	.	.	28	II
	Hypericum perforatum	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	13	II
CU	***Calluno-Ulicetea* Br.-Bl. et R. Tx. ex Klika et Hadač 1944**																																		
	Potentilla erecta	+	+	+	+	+	+	1	1	+	+	2	1	1	2	1	+	1	1	1	1	1	+	1	1	+	1	1	+	+	+	+	1	100	V
	Calluna vulgaris	4	2	4	4	3	4	+	+	+	1	.	+	2	2	+	1	2	2	3	+	1	+	.	1	.	.	.	+	+	.	.	2	78	V
	Luzula campestris	+	+	.	.	.	.	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	+	.	+	+	+	.	41	III
	Carex pilulifera	.	.	.	.	.	.	.	.	.	.	1	+	.	1	1	+	.	1	.	+	.	1	1	.	.	+	.	.	.	.	.	.	+	34	II
	Antennaria dioica	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	+	+	+	+	25	II
	Anthoxanthum odoratum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.	.	.	.	.	+	.	1	16	I
	Botrychium lunaria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	6	I
	Polygala vulgaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	6	I
	Phyteuma spicatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	6	I
CC	***Caricetea curvulae* Br-Bl. 1948**																																		
	Campanula barbata	+	+	+	+	+	+	+	+	.	+	+	+	.	+	+	+	.	+	.	+	+	+	+	.	+	+	.	+	+	+	.	.	75	IV
	Leontodon helveticus	+	+	+	.	.	+	2	+	.	.	.	2	.	+	+	1	.	+	.	.	.	.	+	.	.	1	.	.	+	.	.	+	47	III
	Pseudorchis albida	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	13	I
MA	***Molinio-Arrhenatheretea* R. Tx. 1937 em. R. Tx. 1970**																																		
	Festuca rubra agg.	.	.	.	.	.	.	+	+	.	1	.	.	.	+	1	+	+	+	.	2	3	.	.	+	1	.	+	2	2	.	1	.	50	III
	Lychnis flos-cuculi	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	+	.	.	+	.	+	.	.	+	+	+	+	+	+	+	+	38	II
	Deschampsia caespitosa	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	2	1	2	.	16	I
	Cruciata glabra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	13	I
	Agrostis capillaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	+	.	.	+	.	9	I
	Leucanthemum vulgare	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	9	I
	Ranunculus acris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	9	I
	Molinia caerulea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	6	I
	Euphrasia stricta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	6	I
VP	***Vaccinio-Piceetea* Br.-Bl. in Br.-Bl. et al. 1939**																																		
	Vaccinium vitis-idaea	+	+	2	2	1	1	1	.	+	.	+	+	+	.	+	+	1	1	1	2	2	+	.	.	.	2	.	.	.	+	.	+	69	IV
	Luzula pilosa	.	.	.	.	.	+	.	.	.	.	.	+	+	1	1	.	+	+	+	+	+	.	.	+	+	+	.	.	.	.	.	2	44	III
	Luzula luzuloides	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1	+	.	.	.	+	+	+	+	2	1	1	+	+	.	+	.	41	III
S	***Other species***																																		
	Melampyrum pratense	.	+	+	+	1	+	+	1	+	+	+	1	+	2	1	+	2	1	+	1	.	.	.	.	1	2	1	+	.	+	.	.	75	IV
	Vaccinium myrtillus	+	+	2	.	2	2	.	+	+	+	+	1	+	1	2	+	+	2	2	.	.	.	.	.	.	+	.	.	+	.	+	1	66	IV
	Avenella flexuosa	.	.	.	.	+	1	.	.	.	.	2	2	2	+	2	2	2	2	2	+	+	3	3	2	3	2	.	.	1	.	.	2	63	IV
	Gymnadenia conopsea	.	+	+	.	.	+	+	+	.	+	.	+	.	.	+	+	.	+	.	.	.	.	.	.	.	+	.	.	.	.	+	+	+	44	III
	Hieracium laeviculae	.	.	.	+	.	.	.	.	.	.	+	+	.	+	+	+	.	.	.	1	+	.	+	1	1	+	.	.	+	.	.	.	.	41	III
	Luzula sylvatica	1	+	+	+	+	.	1	.	+	+	.	.	.	.	+	.	+	2	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	38	II
	Anemone nemorosa	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	+	.	+	.	.	.	+	.	.	+	.	.	.	.	.	.	.	19	I
	Gentiana cruciata	.	+	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	19	I
	Crocus napolitanus	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	13	I
	Teucrium chamaedrys	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	6	I
	Hypericum montanum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	6	I
	Stellaria graminea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	6	I
	Rhinanthus pulcher	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	6	I
	Veronica chamaedrys	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	6	I
	LICHENS:																																		
	Cladonia spp.	1	+	.	+	2	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	16	I
	Cetraria islandica	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**6**	I

Locations and sporadic taxa (lokacije in posamezne vrste):
1 - slope of Veliki Črni vrh; 2 - between Mali Črni vrh and Veliki Črni vrh, *Lycopodium clavatum*; 3 - Veliki Črni vrh - Otiše; 4 - slope of Velika Kopa; 5 - V. Črni vrh; 6 - V. Črni vrh; 7 - Mali Črni vrh; 8 - Črni vrh - Otiše; 9 - Mulejev vrh; 10 - Konjiška planja; 11 - Planinka; 12 - Jezerski vrh; 13 - Ostruščica; 14 - Otiše; 15 - Ribniška koča; 16 - Mali Črni vrh; 17 - Ostruščica; 18 - Veliko sedlo, Pungart; 19 - Otiše-V. Črni vrh; 20 - Ostruščica; 21 - Ostruščica-Rogla, *Molinia arundinacea, Carex pallescens*; 22 - Planinka; 23 - Planinka; 24 - Ostruščica; 25 - Ostruščica; 26 - Jezerski vrh; 27 - Ostruščica, *Blechnum spicant*; 28 - Konjiška planja, *Euphrasia rostkoviana, Danthonia decumbens*; 29 - Ribniška koča, *Cerastium glomeratum, Ranunculus platanifolius*; 30 - Otiše - saddle of Pungart, *Trifolium repens, Hieracium pilosella*; 31 - at the foot of Ostruščica; 32 - Velika Kopa-Otiše, *Carlina acaulis, Trifolium pratense.*
Legend (legenda): VP - *Vaccinio-Piceetea*, CC - *Caricetea curvulae*

nostic species of the association as well as the species of the class and alliance are well represented, considering that this are species-poor grasslands. In sampled relevés some species of the classes *Caricetea curvulae* and *Molinio-Arrhenatheretea* are present. Because of the nearby forest and spontaneous reforestation also a larger proportion of forest species is present.

Floristic composition

Four clusters of relevés were separated by TWINSPAN classification. The first 6 relevés represent the most dry and species-poor variant of Pohorje Matgrass swards. It is characterised by high cover of *Calluna vulgaris*, which gives to this grassland formation special physiognomic character. This stands are rich also in some others dwarf-shrubs, namely in *Vaccinium vitis-idaea* and/or *V. myrtillus*. According to some authors *(e.g.* Horvat *et al.*, 1974) they were named also as *"Nardo-Callunetum"*, which was a derivative of the wide interpreted association *"Arnico-Nardetum"*. Those grasslands however do not represent a separate association, but are parts of different Matgrass communities of different vegetation belts and phytogeographical regions. Heaths with *Calluna vulgaris* occur on very shallow soil, poor with minerals and with low pH values. These stands have often parts with bare surface and are more often exposed to erosion (inclination!) than typical variants of the association which predominately occur on flat ground. Relatively high is the proportion of lichens. Dominant are *Cetraria islandica* and different *Cladonia* species.

Relevés from 7 to 19 represent the most "typical" form of the *Homogyno-Nardetum* association. These stands are found on the gentle sloping ridges of the tops of Pohorje: from Volovica over Rogla, Mulejev vrh and Planinka; from Ribniško Pohorje over Črni vrh, Pungart to Mala Kopa and Velika Kopa. Species characteristic of this "central" variant are *Arnica montana, Veratrum album* subsp. *album, Homogyne alpina, Gentiana pannonica, Carex pilulifera, Hieracium aurantiacum, Festuca rubra* and *Leontodon helveticus*. Only occasionally also *Hypochoeris uniflora* and *Potentilla aurea* could be found. According to some historical data (Petkovšek, 1952) also *Gentiana acaulis* appears on Pohorje Mts. We could expect it also in this type of grassland stands unless it was found in lower altitude (at Pesnik) (Petkovšek, 1952; T. Wraber, 1967, *oral communication).* Since these stands are in the stage of slow spontaneous reforestation, it is possible, that *Gentiana acaulis,* because of the successful competition of (ungrazed) grass species, has firstly regressed and finally disappeared from Pohorje. Characteristic species of these Matgrass swards and specially those on higher altitudes is also *Rhinanthus pulcher.*

Cluster with relevés from 27 to 32 represent more eutrophic (mesophile) variant of Matgrass swards, characteristic of saddles, flat plains and even small hollow depressions when they are not too moist. Soil is deeper and richer with nutrients. Such grasslands are also of major economic value. They are used as meadows and pastures. Larger is the proportion of the *Molinio-Arrhenatheretea* species (Tab. 1), such as *Festuca rubra* agg., *Deschampsia caespitosa, Lychnis flos-cuculi, Cruciata glabra, Ranunculus acris etc.* Relevés from 20 to 26 are transitional forms from typical to the grasslands with higher eutrophication level.

Matgrass grasslands can also become marshy. Acid soil and additional acidification due to the water stagnation lead to the appearance of species of raised bogs and intermediate mires of the classes *Oxycocco-Sphagnetea* and *Scheuchzerio-Caricetea fuscae.* First *Molinia caerulea* begins to dominate. These stages in which still some Matgrass grasslands species could be found, become floristically poorer. *Nardus stricta* slowly gives way to mesophilous *Carex* and grass species *(e.g. Carex canescens, C. pilulifera, Danthonia decumbens)* and shortly afterwards *Eriophorum angustifolium* and *E. vaginatum* become dominant. Some authors *(e.g.* Wagner, 1954; Ellmauer, 1993) classify such intermediate stages still within the Matgrass swards. However, they present the separate atlantic alliance *Nardo-Juncion squarrosi* (Oberd. 1957) Passarge 1964. Our opinion is that such vegetation formation are already outside of grassland vegetation: *Nardus stricta* remains because of its tolerance of the humidity and acidity. Relevés of such stands were therefore not placed within vegetation discussed in these study.

Geo-elements

The chorological structure of the association (Fig. 2) with the absence of Illyrian species and with the high portion of European (including Alpine) geo-elements confirms geographical position of Pohorje Matgrass swards at the easternmost edge of the Central Alps. Almost one third of the species represent Circumboreal, Arctic-Alpine and Alpine geo-elements. Second third represent Eurasian, European and Eurosiberian geo-elements and the rest Mediterranean-Montane, Eurimediterranean and Cosmopolite species.

Ecological conditions

Ellenberg indicator values

Ecological conditions of the stands were estimated by Ellenberg indicator values (Ellenberg *et al.*, 1991) for light, temperature, soil moisture, pH and nitrogen content (Fig. 3). Mean values of weighted averages were calculated for each group (cluster) of relevés: (1) heath, (2) typical stands, (3) transitional stands between (2) and (4), (4) relatively eutrophic stands.

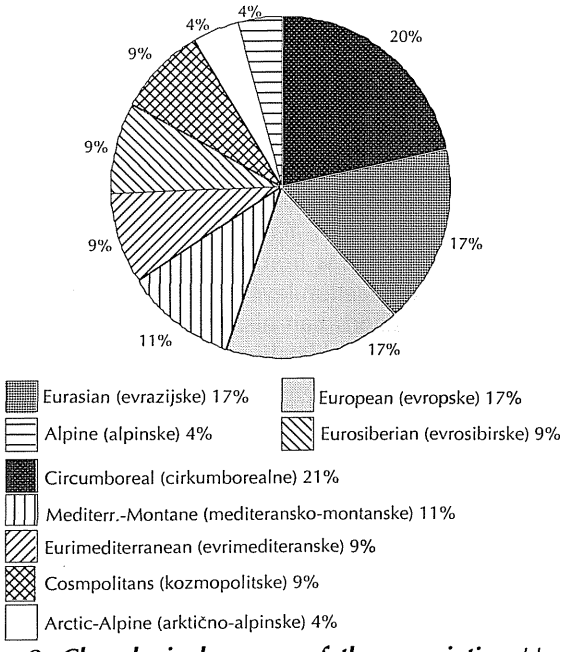


Fig. 2: Chorological groups of the association** Homogyno alpinae-Nardetum **in the area of Pohorje.
Sl. 2: Geoelementna sestava asociacije** Homogyno alpinae-Nardetum **na območju Pohorja.

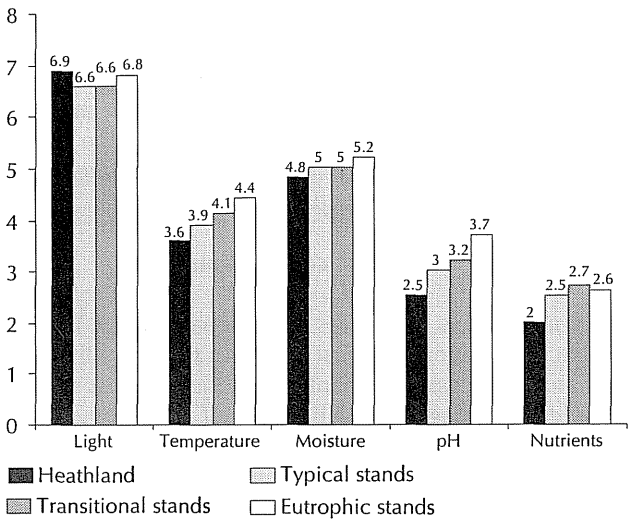


Fig. 3: Mean values of weighted averages of Ellenberg indicator values for four (4) groups (clusters) of relevés of** Homogyno alpinae-Nardetum **association.
***Sl. 3: Povprečje tehtanih (ponderiranih) srednjih vrednosti Ellenbergovih indeksov za štiri skupine (klastre) popisov asociacije** Homogyno alpinae-Nardetum.*

The Ellenberg light-values show, that in all stands heliophilous grasslands species are predominating. Apart from altitudinal levels we deal with species of open and sunny habitats. Indicator values for temperature show gradient from relevés of heaths (the lowest value) to eutrophic stands (the highest value), which we interpret with the occurrence of sporadic sub-Alpin species in heaths and in typical formation. In the eutrophic stands also some species of lowland intensive-used grasslands are present. Humidity doesn't vary much; the lowest value was calculated for heath and the highest for eutrophic stands, with deeper and therefore more humid and nutrients-rich soil. Ellenberg reaction values clearly show acidophilous character of studied Matgrass swards. According to the species, soil reaction is the lowest in heaths and the highest in eutrophic stands. Also soil fertility does not differ much between clusters. However heath stands appeared to be less fertile than others.

Spontaneous reforestation of Pohorje plains

Matgrass grasslands of Pohorje have a semi-natural origin, *i.e.* they had been developed and are maintained because of the human activities. Due to the changes in traditional land-use, most plains of Pohorje are no longer used for grazing and mowing and are increasingly being regrown by trees. The natural reforestation process is relatively slow and could be noticed throughout a longer period. Main factors which slow down this secondary succession are: 1. short vegetation season due to the montane climate; 2. absence of the shrubs, which generally play important role in the process of reforestation; 3. acid soil causes lower species-richness than lime-rich soil – lower species-richness has negative influence on the secondary succession; and 4. absence of invasive Umbelliferous species *(e.g. Laserpitium siler, L. latifolium* on limestone), which in many cases become competitive since the removal of man's influence. However, the process of spontaneous reforestation is making progress. A determining role play favourable edaphic conditions, *e.g.* in small depressions and on the slopes with deeper soil which has more water-holding capacity. In such stands *Carex brizoides*, which is otherwise typical for wet lowland forests, becomes absolutely dominant and can form pure stands. *Carex brizoides* become very invasive species, which overgrows other smaller plants and is spreading by rhizomes. Moisture and shade are favourable ecological conditions, which comes with its invasion. We can often observe how the isolated tree or group of trees in the middle of plains represent nucleus of spontaneous reforestation (Kaligarič, 1995). When the reforestation process starts with *Carex brizoides* stages, not concentric, but asymmetric patches are formed, due to the fact that there is more sedge on the shady than on the sunny site of the trees. Stands with *Carex brizoides* are very species-poor – heliophilous grassland species are reduced, while the penetration of forest species is very slow. At the same time two woody species appear – spruce *(Picea abies)* and mountain ash *(Sorbus aucuparia),* and also sporadic forest species of the herbaceous layer: *Anemone nemorosa, Solidago virgaurea,*

Polygonatum multiflorum, etc. However the sedge is not always the first coloniser of the fallow plains. On dry places first spruce or mountain ash start to germinate. They change microclimate by giving shadow and enable enlarging of the nucleus of reforestation (Kaligarič, 1995). Very successful is also spreading of already existent forest. Its frontal part slowly approaches the grassland centre and narrows its area. The smaller is grassland area the greater is effect of forest on the microclimate. The solar radiation is now converted at the level of the woodland canopy and cannot reach the lower growing plants. Decisive influences have higher humidity and lower temperatures in summer time. Many helio- and thermophilous herbaceous plants are being suppressed by dwarf-shrubs like *Vaccinium myrtillus* on dry and *Carex brizoides* on humid sites.

PRISPEVEK K POZNAVANJU VEGETACIJE SUHIH TRAVIŠČ OVRŠNIH PREDELOV POHORJA (SLOVENIJA)

Mitja KALIGARIČ & Sonja ŠKORNIK
Oddelek za biologijo, Pedagoška fakulteta, SI-2000 Maribor, Koroška 160 in
Inštitut za biodiverzitetne študije, Znanstveno raziskovalno središče Republike Slovenije Koper, SI-6000 Koper, Garibaldijeva 18
E-mail: mitja.kaligaric@uni-mb.si; sonja.skornik@uni-mb.si

POVZETEK

Avtorja sta vzorčila sestoje suhih travišč – planj in resav na ovršnih predelih Pohorja po standardni Braun-Blanquetovi metodi. Ugotovila sta, da so travišča na najvišjih predelih precej uniformna, floristično skromna in da se počasi zaraščajo. Travišča pripadajo redu sekundarnih travišč na silikatih Nardetalia *Oberd. ex Preising 1949, zvezi volkovij* Nardo-Agrostion tenuis *Sillinger 1933. Ker so ta travišča že blizu gozdne meje (ki na Pohorju sicer ni dosežena) segajo vanje tudi vrste iz naravnih subalpinskih volkovij (zveza* Nardion, *razred* Caricetea curvulae). *Tako tvorijo mešanico z izrazito subalpinskim vplivom in hkrati prevladujočim kontingentom nižinskih nardetalnih in arenateretalnih vrst, kar smo – poleg nadmorske višine, ki ne dosega gozdne meje – upoštevali tudi pri uvrstitvi. Ugotovili smo asociacijo* Homogyno alpinae-Nardetum *Mráz 1956, ki je po vsem ovršnem delu Pohorja precej enotna, variira pa glede na talne razmere, zasenčenost in stopnjo evtrofiziranosti. Na plitkih tleh z razgaljeno matično kamnino je floristična sestava skromnejša. V večji meri se pojavljajo vrste* Calluna vulgaris, Antennaria dioica, *lišaji (npr.* Cetraria islandica *in vrste rodu* Cladonia *spp.), ind. Ta tip vegetacije je poznan pod imenom pohorske resave. V zasenčenih legah se pojavljajo gozdne vrste in* Carex brizoides, *v bolj evtrofiziranih razmerah pa arenateretalne vrste. Asociacija je optimalno razvita na sončnih, suhih rastiščih z rahlim naklonom.*

Geoelementna sestava z odsotnostjo ilirskih vrst in s prisotnostjo evropskih elementov, vključno z alpinskim, potrjuje lego pohorskih planj na zadnjem JV odseku Centralnih Alp. Sinekološke značilnosti obravnavane vegetacije smo ocenjevali z Ellenbergovimi indeksi za svetlobo, temperaturo, vlažnost, pH in hranilnost. Indeks za svetlobo kaže, da na teh travišcih prevladujejo heliofilne vrste. Medtem ko so najbolj topla, vlažna ter z najvišjim pH rastišča bolj evtrofiziranih sestojev, so najbolj zakisana in s hranilnimi snovmi siromašna rastišča resav.

Zaradi opustitve paše oziroma košnje se velik del pohorskih planj zarašča z gozdom. Zaraščanje je sicer počasnejše v primerjavi s tistim iz nižin ali na apnencu vendar kljub temu napreduje. Razlikujemo več tipov zaraščanja: (1) na tleh z več vlage poteka zaraščanje z migaličnim šašom (Carex brizoides), *(2) na suhih tleh se prične zaraščanje z uspešno kalitvijo smreke ali jerebike, ki ustvarita uspešno mikroklimo za večanje jedra zaraščanja in (3) širjenje že obstoječega gozda.*

Ključne besede: suha travišča, silikati, volkovja, *Nardo-Agrostion tenuis, Homogyno alpinae-Nardetum,* Pohorje, Slovenija

REFERENCES

Aichinger, E. (1933): Vegetationskunde der Karawanken. Gustav Fischer Verlag, Jena, 329 pp.

Braun-Blanquet, J. (1964): Pflanzensoziologie. Grundzüge der Vegetationskunde. Springer Verlag, Wien New York, 330 pp.

Cenčič, L. (1985): Gozdni rezervati Slovenije: Pragozd Šumik MB 05. Biotehniška fakulteta, VTOZD za gozdarstvo, Ljubljana, 52 pp.

Culiberg, M. & A. Šercelj (2000): Spremembe prvotnih gozdov na Pohorju v zadnjih stoletjih z vidika pelodne analize. *Changes in the primary forests on the Pohorje Mts. During the past centuries established by the pollen analysis.* Razprave 4.r. SAZU, Ljubljana, 3-39.

Dierschke, H. (1994): Pflanzensoziologie: Grundlage und Methode. Stuttgart, Ulmer, 683 pp.

Ellenberg, H. (1996): Vegetation Mitteleuropas mit den Alpen. Ulmer, Stuttgart, 1095 pp.

Ellenberg, H., H. E. Weber, R., Düll, V., Wirth, W. Werner & D., Paulissen (1994): Zeigerwerte von Pflanzen in Mitteleuropa. Scripta Geobot. 18, Göttingen, 1-248.

Ellmauer, T. (1993): *Calluno-Ulicetea*. In: Mucina, L., G., Grabherr & T., Ellmauer (eds.): Die Pflanzengesellschaften Österreichs. Teil I. Jena, Gustav Fischer Verlag, 402-419.

Gigon, A. (1971): Vergleich alpiner Rasen auf Silikat- und auf Karbonatboden. Veroff. Geobot. Inst. ETH, Stiftung Rübel 48, 164 pp.

Grabherr, G. & L., Mucina (eds.) (1993): Die Pflanzengesellscahften Österreichs. Teil II, Gustav Fischer Verlag, Jena, 523 pp.

Hayek, A. (1923): Pflanzengeographie von Steiermark. Mitt. D. Naturwiss. Ver. F. Steiermark 59, Graz, 208 pp.

Hayek, A. (1908-1956): Flora von Steiermark. Berlin, Verlag von gebrüder Borntraeger, Band I, II.

Hill, M. O. (1979): DECORANA: A fortran program for detrended correspondence analysis and reciprocal averaging. Cornell University, Ithaca, NY.

Hinterlechner-Ravnik, A. (1995): O geologiji Pohorja. Proteus 57 (9-10), 334-339.

Horvat, I., V., Glavač & E., Ellenberg (1974): Vegetation Südosteuropas. Stuttgart, Gustav Fischer Verlag, 768 pp.

Jež, M., (1995): Pohorje. Proteus 57 (9-10), 331-333.

Kaligarič, M. (1993): Flora in vegetacija na pohorskih planjah. Dvoletno poročilo o terenskem delu. Zavod za varstvo narave in kulturne dediščine Maribor, Maribor.

Kaligarič, M. (1995): Rastlinski svet pohorskih planj. Proteus 57 (9-10), 340-347.

Krahulec, F. (1985): The chorologic pattern of European *Nardus*-rich communities. Vegetatio 59: 119-123.

Krahulec, F. (1988): Nomenclatural remarks on the association names of *Nardus stricta*-rich communities in Central Europe. Praha, Fol. Geobot. Phytotax. 23, 173-179.

Marinček L. (1987): Bukovi gozdovi na slovenskem. Beech forest in Slovenia. Ljubljana, Delavska enotnost, 153 pp.

Martinčič, A. & M. Piskernik (1985): Die Hochmoore Sloweniens. Biol. vestnik, vol. Extraord. 1, Ljubljana, 239 pp.

Martinčič, A., T., Wraber, N., Jogan, V., Ravnik, A., Podobnik, B., Turk & B., Vreš (1999): Mala flora Slovenije. Ključ za določanje praprotnic in semenk. Tretja, dopolnjena in spremenjena izdaja, Tehniška založba Slovenije, Ljubljana, 845 pp.

Mucina, L., G., Grabherr & T., Ellmauer (eds.) (1993): Die Pflanzengesellschaften Österreichs. Teil I. Gustav Fischer Verlag, Jena, 578 pp.

Oberdorfer, E. (1957): Suddeutsche Pflanzengesellschaften. Gustav Fischer Verlag, Jena.

Oberdorfer, E. (1978): Klasse: *Nardo-Callunetea* Prsg. 49. In: Oberdorfer, E. (ed.): Süddeutsche Pflanzengesellschaften. Teil II. 2. Aufl., Gustav Fischer Verlag, Jena, 208-248.

Peterseil, J., K., Reiter & D., Moser (1998): Jodi 97 Expertensystem. Datenbankapplikation zur Identifikation und Analyse von vegetationsaufnahmen. Universität Wien.

Petkovšek, V. (1952): Nekatere nove ali redke vrste rastlin na slovenskem. Biološki vestnik, 1, 18-37.

Piskernik, M. & A. Martinčič (1970): Vegetacija in ekologija gorskih barij v Sloveniji. Zbornik 8, Biotehniška fakulteta, Inštitut za gozdno in lesno gospodarstvo.

Poldini, L. (1991): Atlante corologico delle piante vascolari nel Friuli-Venezia Giulia: inventario floristico regionale, Udine 899 pp.

Preising, E. (1949): *Nardo-Callunetea*. Zur Systematik der Zwergstrauch-Heiden und Magertriften Europas mit Ausnahme des Mediterran-Gebietes, der Arktis und der Hochgebirge. Mitt. Florist.-Soziol. N.F. 4, 82-94.

Reiter, K. (1998): VEGI. Programm zur Erstellung von Vegetationstabellen. Universität Wien.

Steinbuch, E. (1995): Wiesen und Weiden der Ost-, Süd und Weststeiermark. Eine vegetationskundliche Monographie. Diss. Bot. Band 253, 137-168.

Wagner, H. (1954): Der Moorrand-Burstlingrasen, eine räumlich-ökologische Kontaktgesellschaft. Angew. Pflanzensoziol., Wien, Festsschrift Aichinger, 674-683.

Westhoff, V. & E., van der Maarel (1973): The Braun-Blanquet approach. In: Whittaker, R.H. (ed.): Ordination and classification of communities. Handb. Veg. Sci. 5, 156-172.

Wraber, M. (1953): Tipološka podoba vegetacije višjih predelov Pohorja. Biološki vestnik 2, 89-109.

Wraber, M. (1954): Splošna ekološka in vegetacijska oznaka višjih predelov Pohorja. Gozdarski vestnik, 12, 161-178.

Wraber, M. (1955): O problemu vegetacijskega klimaksa na Pohorju. Biološki vestnik 4, Ljubljana, 7-22.

Wraber, M. (1956): Fitosociološka in ekološka razširjenost dendroflore na Pohorju. Biološki vestnik 5, 39-70.

Wraber, M. (1960): Fitocenološka razčlenitev gozdne vegetacije v Sloveniji. *Ad annum Horti botanici labacensis solemnem*, Ljubljana, 49-96.

Wraber, M. (1963): Gozdna združba smreke in gozdne bekice v slovenskih Vzhodnih Alpah *(Luzulo sylvaticae piceetum* Wraber 1953). Razprave 4.r. SAZU, 7, Ljubljana, 79-175.

Wraber, T. (1971): Teden dni med cvetjem na Pohorju. Planine ob meji (20-21), PD Mariborska matica, Maribor, 96-102.

Zupančič, M. (1998): Smrekovi gozdovi Slovenije. *Spruce forest in Slovenia*. Razprave 4 r. SAZU, Ljubljana, 222 pp.

EKOLOGIJA

ECOLOGIA

ECOLOGY

review
received: 20. 5. 2002

UDC 504.3(262+262.3)

THE IMPACT OF AFRICAN DUST ON THE NORTHERN ADRIATIC

Nives KOVAČ
Marine Biology Station, National Institute of Biology, SI-6330 Piran, Fornače 41

ABSTRACT

Atmospheric input has a significant impact on the marine environment. African dust originating in the arid and semiarid regions of northwestern Africa is the major source of natural atmospheric particles over to Mediterranean. Therefore, the current understanding of the role and effects of dust inputs to the Mediterranean has been reviewed and possible influence of these eolian dust deposits to the northern Adriatic highlighted.

Key words: African (Saharan) dust, Mediterranean, northern Adriatic, atmospheric input

IMPATTO DELLA POLVERE AFRICANA SUL NORD ADRIATICO

SINTESI

L'input atmosferico ha un impatto importante sull'ambiente marino. La fonte maggiore di particelle atmosferiche naturali che raggiungono il Mediterraneo è la polvere africana che ha origine nelle regioni aride e semiaride dell'Africa nord-occidentale. L'articolo pertanto presenta un resoconto delle conoscenze attuali sul ruolo e sugli effetti degli input di polvere nel Mediterraneo, nonché mette in risalto la possibile influenza dei depositi di tale polvere eolica sul Nord Adriatico.

Parole chiave: polvere africana (Sahariana), Mediterraneo, Nord Adriatico, input atmosferico

INTRODUCTION

Atmosphere is an important route for transport of aeolian particles, natural and pollutant, to the coastal and open seas. Atmospheric aerosols and rainwaters consist of inorganic and organic anthropogenic and biogenic compounds related to several emissions (Guerzoni *et al.*, 1999a). These substances include mineral dust, plant residues, heavy metals, nitrogen species from combustion processes an fertilisers, pesticides, and wide range of synthetic organic compounds from industrial and domestic sources. Recently, there has been much interest in atmospheric inputs, especially Saharan dust, and their impact on marine biogeochemistry (Martin *et al.*, 1989; Jickells, 1999; Guerzoni *et al.*, 1999a), oceanic sedimentation and sediment (Loÿe-Pilot *et al.*, 1986; Molinaroli, 1996, Węgrzynek *et al.*, 1997), soils (Herrmann *et al.*, 1996), and climate (Andreae, 1996; Tegen *et al.*, 1996).

The aim of the present paper is to review recent studies about the characteristics of the African dust inputs to seawater, especially to the Mediterranean, and to highlight the possible effects of dust transport to the northern Adriatic.

GENERAL OVERVIEW

A number of dust sources exists in arid regions of Africa (North Africa, Sahara, Sahel) which are active all year, especially during the summer when they feed strong pulses of dust across the Mediterranean to Europe and the Middle East and across the Atlantic to Caribbean, Central and North America (Prospero, 1996). African dust is frequently deposited also in the Alps and the Balkans (Vukmirović *et al.*, 1999) and sometimes reaches Scotland and Scandinavia (Tomadin *et al.*, 1996; Hjelmroos, 1996). The impact of African dust could be indicated also from the composition of ice inglaciers (De Angelis & Gaudichet, 1991). Inputs of desert aerosol are often described as events of "red snow" and "red rain" (Prodi & Fea, 1979; Bücher *et al.*, 1983) or "yellow rain" (Vukmirović *et al.*, 1999). Instead of "African", the generic term "Saharan" is frequently used that mainly relates to the northwestern part of Africa. However, Africa is not the only source. Western and central China is a source of yellow dust, which can scatter across Japan and the Pacific Ocean, but fine particles can also travel as far as North America and even the Antarctic Circle. In the present text, however, the desert dust related to Africa will be discussed.

The dust episodes bring mainly inorganic particles dominated by quartz, calcite and clay and minor fraction of organic material, even such as exotic pollen (Hjelmroos, 1996). Additionally, "pulses" of Saharan dust seasonally carry large amounts of metals of natural origin (Guerzoni *et al.*, 1999b).

These aerosols are mainly produced by aeolian erosion occurring in arid or semiarid areas. The emission strength is highly sensitive to changes of some climatic parameters such as wind velocity and precipitation (Marticorena & Bergametti, 1995). During long range transport, aerosols are modified by a variety of physicochemical processes (Jickells, 1999) and once the dissolved and particulate atmospheric inputs reach the ocean they become subject to variety of biogeochemical processes. The amount of particles precipitated and the size and composition of the particles vary depending on transport distance, wind and place of origin of the material (Molinaroli & De Falco, 1995). The majority of dust emissions is sporadic, spatially heterogeneous and large scale-variable, therefore the assessment of their impacts is difficult and remote sensing is essential tool for its study. Atmospheric dust can be readily observed by satellite (Meteosat, Sea-viewing Wide field-of-view Senzor *i.e.* SeaWIFS, TOMS satellite imagery, OSEI, AVHRR,...), so several studies of atmospheric transport and deposition of dust are based on satellite images (Dulac *et al.*, 1996; Moulin *et al.*, 1997a, 1997c, 1998). Furthermore, many model simulations of Saharan dust episode have been made (Marticorena & Bergametti, 1995, 1996; Marticorena *et al.*, 1997; Chiapello *et al.*, 1997; Giorgi, 1996; Schulz *et al.*, 1998). Surface observations and modelling data are available On line (AERONET, NRL Surface, NRL Model).

MAIN TOPICS IN STUDIES OF THE IMPACTS OF AFRICAN DUST

Dust science is on the rise (in the last two decades), so several environmental effects of long-range transport and input of African dust have been proposed by different studies.

Atmospheric aerosols are of climatic importance due to their optical properties to absorb and scatter solar radiation depending on their chemical composition (Li *et al.*, 1996; Tegen *et al.*, 1996). The indirect effect on climate is linked to the formation of cloud condensation nuclei (CNN) and consequently to the number of cloud droplets, which enhance short-wave albedo of clouds (Houghton *et al.*, 1995). Consequently, clouds become microphysically unstable which leads to effective rain production (Levin & Ganor, 1996). The connection between dust and increasing snow signal (http://www.rnw.nl/science/html/sahara010219.html) has also been reported. Additionally, some scientist theorize that increasing amounts of aeolian dust could keep the temperature down by decreasing the amount of sunlight (http://news.nationalgeographic.com/news/2000/07/0710_dust.html).

Dust events influence also the pH of rainfall (Loÿe-Pilot *et al.*, 1986) and because the particles are chemically alkaline some scientists suggest their importance in

neutralising acid rain (http://news.nationalgeographic.com/news/2000/07/0710_dust.html).

Some studies suggest that Saharan dust may play an important role in determining the frequency and intensity of hurricanes formed in the eastern Atlantic ocean (http://www.thirdworld.org/role.html).

Atmospheric supply of African dust material to the ocean seems to play a central role in trace matter chemistry of seawater (Remoudaki *et al.,* 1991; Guerzoni *et al.,* 1997, 1999a; Jickells, 1999).

Several studies indicate a strong correlation between dust inputs and different biological response. Recently, there is increased interest in the deposition of mineral dust to the oceans because of aerosol iron (Carder *et al.,* 1991; Zhu *et al.,* 1997), which is believed to be an important limiting nutrient for phytoplankton growth. The role of iron delivered by Saharan dust and ecology of harmful algal blooms (red tides) has been studied and reported by Lenes *et al.* (2001). There is also evidence that dust provides essential nutrients for Amazonian rain forests (Swap *et al.,* 1992). Moreover, the demise of coral reefs in the Caribbean basin was also linked to African dust and it is also hypotesized that African dust may also contribute to the global rise in respiratory infections (http://newscientist.com/ns/19990703/newstora10.html).

DUST OVER THE MEDITERRANEAN

Sources and chemical characterization of African dust

Atmospheric input is especially important in shelf seas and semi-enclosed seas such as the Mediterranean (Martin *et al.,* 1989) and as several millions of tons of particulate matter are transported from north Africa to the Mediterranean countries the study of dust transport and impacts in the Mediterranean is receiving increasing attention. The Mediterranean Sea borders on its northern shore to the highly industrialised regions, which act as a continuous source of anthropogenic *i.e.* urban-rich material to the atmosphere, and on its southern and eastern shores to arid and desert regions, including the Sahara and the Middle Eastern deserts (Molinaroli & De Falco, 1995). The most productive African dust sources have been selected and defined by different authors (D'Almeida, 1986; Avila *et al.,* 1996). Saharan dust originating from north Africa is the major source of natural atmospheric particles over the Mediterranean (Molinaroli & Ibba, 1995), and Libyan desert has been indicated as a major source of dust over the eastern Mediterranean (Moulin *et al.,* 1998). These areas are acting as sources of crustal material, which is transported largely in the form of non-continuous, dust "pulses" (Chester *et al.,* 1997). The anthropogenic and desert materials are chemically very different, in particular with respect to their trace metal content (Guieu & Thomas, 1996). Typical crustal elements are Al, Si, K, Ca, Ti, Fe, Mn, Rb, Co, Ba, and elements such as S, Zn, Pb, Cu, Cd and Br are mainly associated with anthropogenic activity (Bonelli *et al.,* 1996; Frau *et al.,* 1996). These inputs significantly influence the mineralogical and chemical composition of Mediterranean aerosol (Molinaroli *et al.,* 1999). The detailed estimates of atmospheric inputs to the Mediterranean were reviewed by Guerzoni *et al.* (1999a).

In the material collected over the Mediterranean basin, a wide types of crust-derived minerals such as clay minerals, quartz, feldspars, micas, calcite, dolomite and hematite have been identified (Molinaroli, 1996). Despite different chemistry in all cases, quartz, calcite and clays are the major components and among them clay minerals could be used as "source tracer" (Tomadin *et al.,* 1996; Molinaroli, 1996). Palygroskite is characteristic dust mineral of the north-west African origin in the Western Mediterranean samples (Molinaroli & Ibba, 1995; Molinaroli, 1996) and in the Eastern Mediterranean was more frequently detected smectite (Molinaroli, 1996). Kaolinite, common in desert weathering regimes, is more abundant in dust originating from eastern compared to the western Sahara and the highest concentrations have been observed off the Egyptian coast (Guerzoni *et al.,* 1999a). Moreover, the comparison of the illite/kaolinite ratio in the African dust and sediment of the Mediterranean could be used for indication of the contribution of dust (from different sources) deposition (Guerzoni *et al.,* 1999a). Similar, titanium was also proposed to be a good tracer-element for dust events and also the Ti/Ca, Ti/Fe and Al/Si concentration ratios (Bonelli *et al.,* 1996). Backward trajectories have shown (Chiapello *et al.,* 1997) that the calcium amount and Si/Al ratio of the transported dust differs according to the source regions (Sahel, north/west Sahara, south/central Sahara), in relation to their respective soil compositions.

Transport and deposition to the Mediterranean

Major dust storms are highly episodic and the direction of transport is also seasonal. The dust event is associated with appropriate conditions to mobilise and transport it to high altitude to allow long-range transport and it is climatically controlled (Schutz *et al.,* 1990). Routes of Saharan dust were studied for the western and central Mediterranean (Ganor & Mamane, 1982; Molinaroli & Ibba, 1995; Bonelli *et al.,* 1996) and also for the Eastern Mediterranean (Prodi & Fea, 1979) by several authors. Annual cycle of dust transport in Mediterranean atmosphere, deduced from climatological results, begins in spring over the eastern basin, has a maximum in summer over the western and central basins, and strongly decreases during autumn and winter (Moulin *et al.,* 1998). Spring and early summer constitute the favourable period for the sharav cyclones that move eastward along the north African coast cross the Mediterranean towards the north between Tunisia and

Egypt. In summer, the Saharan depression is combined with the semipermanent ridge over Libya and the associated dust transport occurs over the western and central Mediterranean (Moulin *et al.*, 1997c). The Scirocco wind may transport desert-derived dust from north Africa across the Mediterranean to Sicily, Sardinia, and the Italian Peninsula where, on termination of winds by passage of cold fronts, the dust burden is deposited in the so called "red rains" (Molinaroli & Ibba, 1995). These events are frequently observed also in the northern Adriatic and its hinterland.

Global estimates of dust deposition to the Mediterranean Sea range from ~25 to ~100 Tg yr^{-1} (Prospero, 1996). The deposition of dust occurs whether as dry *(i.e.* not involving an atmospheric aqueous phase) or wet deposition (precipitation scavenging). Both depositions are quite frequent over the Mediterranean (Molinaroli, 1996). In general, the wet deposition controls the flux of Saharan dust to the Mediterranean Sea and can sometimes occur only with a few raindrops (Loÿe-Pilot & Martin, 1996). However, the dry deposition can also be important (Guerzoni *et al.*, 1997). The wind-blown dust transported to the Eastern Mediterranean is mainly deposited by dry deposition, while in the Western Mediterranean wet deposition is dominant (Molinaroli, 1996).

Recent work and main results

Mediterranean Dust Data Base (MDDB) has been designed as the final product of the European MEDUSE (Mediterranean DUSt Experiment) Project. It started off on March 1, 1996 (and ended on April 30, 1998), its overall objective being to develop and to implement a prototype system for routine monitoring and prediction of atmospheric transport of desert dust in the Mediterranean region. An overview of remote sensing studies of African dust in the Mediterranean region was presented by Dulac *et al.* (1997). Moreover, in 2001 the Mediterranean Israeli Dust Experiment (MEIDEX) was launched, its main objective being to investigate desert aerosol physical properties, transportation, and its effect on the energy balance and chemistry of the ambient atmosphere with possible applications to weather prediction and climate simulation (http://www.tau.ac.il/geophysics/MEIDEX/home.htm).

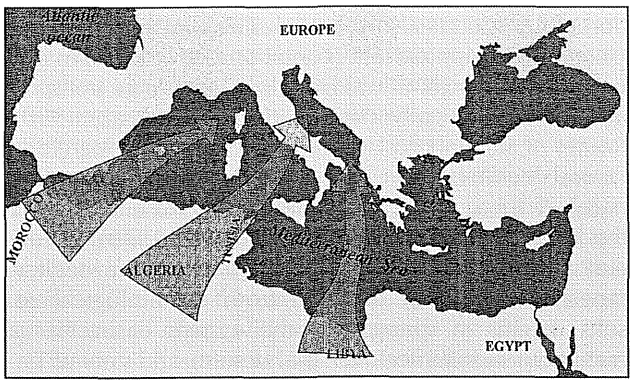


Fig. 1: Shematic trajectories of African dust input in western Mediterranean and Adriatic Sea.
Sl. 1: Shematski prikaz vnosa afriškega peska v Jadransko morje in zahodni del Sredozemskega morja.

The most complete review of the impact of desert dust to the Mediterranean was presented by Guerzoni & Chester (1996) who had collected a number of papers given at the ADAM (The impact of African Dust Across the Mediterranean) conference held in Oristano, Sardinia, from 4-7 October 1995. However, most of the published studies on the atmospheric input of biogenic and anthropogenic compounds into the Mediterranean seawater were conducted in its western part (Bergametti *et al.*, 1989; Remoudaki *et al.*, 1991; Bergametti *et al.*, 1992; Carratalà *et al.*, 1996; Molinaroli *et al.*, 1999) and some studies were performed in the Eastern Mediterranean region (Levin & Ganor, 1996; Ganor & Foner, 1996; Mihalopoulos *et al.*, 1997; Herut *et al.*, 1999).

Dust inputs have a significant impact on the mineralogical composition of Mediterranean aerosol and on composition of the deep-sea sediments (Molinaroli, 1996). It was shown that the sources, the mineralogical composition, the trajectories of desert dusts as well as the sedimentation rate and the sedimentological properties of deep-sea sediments in the Western and Eastern Mediterranean are different (Molinaroli, 1996). There is strong evidence that atmospheric transport of trace elements related to African dust play a significant role on the geochemistry of the Mediterranean marine environment. Martin *et al.* (1989) reported that the atmospheric input of red dust is of the same order of magnitude as the annual downstream flow of rivers discharging to the Western Mediterranean and the atmospheric flux of Cu, Pb, and Cd exceeds river input by one to two orders of magnitude. The importance of mineral dust in influencing atmospheric and seawater (the distribution in the Mediterranean sea) concentrations of Mn (Remoudaki *et al.*, 1991; Guieu *et al.*, 1994), Fe (Bergametti *et al.*, 1989; Dulac *et al.*, 1996), Al (Dulac *et al.*, 1989; Guieu & Thomas, 1996), Cu (Remoudaki *et al.*, 1991; Chester *et al.*, 1996), Ti (Bonelli *et al.*, 1996), Pb, Zn (Chester *et al.*, 1996), Cd (Vukmirović *et al.*, 1999) and Zn, As *etc.* (Güllü *et al.*, 1996) have been also studied.

The major control on solubility of metals (Prospero *et al.*, 1987; Spokes *et al.*, 1994; Guerzoni *et al.*, 1999a) is thought to be the pH, governed by a balance between the acidic and neutralizing species present in precipitation. Rain waters coupled with air masses which had crossed Western Europe and had scavenged black particulate "urban-dominated" material from the air give rise to acidic rains. On the other hand, rain waters associated with air masses which had crossed North African sources,

and which had scavenged red "crust-dominated" Saharan dust result in neutral to basic rains as a result of dissolution of calcium carbonate from the desert-derived aerosols (Chester *et al.*, 1997). Regarding the impact of dust on the rain acidity which effects rainwater chemistry, such as trace metal solubility and their further sea fluxes, several studies have been carried out in the Mediterranean (Loÿe-Pilot *et al.*, 1986; Loÿe-Pilot & Morelli, 1988; Chester *et al.*, 1996, 1997; Frau *et al.*, 1996, 1997; Carratalà *et al.*, 1996). Besides the trace metals, the strong SO_4^{2-} enrichment is widely observed in long-range transported Saharan dust. Deep ice core analyses (Wagenbach *et al.*, 1996) suggested that desert dust could pick up, transport and remove atmospheric sulphur and also contribute to natural SO_4^{2-} flux. That could be partly attributed to desert-derived gypsum (Loÿe-Pilot & Morelli, 1988). Dust usually also contains higher phosphorus concentration but solubility of inorganic phosphorus in seawater is lower. However, such dust events may still contribute to high amounts of phosphorus to the surface waters (Herut *et al.*, 1999) and in a highly stratified layer this source of phosphorus concentration would be more significant (Guerzoni *et al.*, 1999a). Bergametti *et al.* (1992) reported that in summer the atmospheric source of phosphorus concentration is dominant in the western Mediterranean, and that this input may account for new production. After the wet deposition of dust several blooms have been observed in the Mediterranean and in enclosed basins like the Black Sea (Saydam & Yilmaz, 1998; Saydam & Polat, 1999). Something similar, *i.e.* that such Saharan dust fallout may explain some summer algal blooms, was proposed by Dulac *et al.* (1996). Nevertheless, despite several observations of a biological response after dust storm, the causal relationship is not yet explained (Guerzoni *et al.*, 1999a). Saydam (1996) presented the most studied theory, known as Cemiliana hypothesis. He suggests that wet dust intrusion of iron supplied in marine environment from desert regions that has been photochemically reduced within cloud droplets to bioavailable Fe(II) oxidation stage resulted in phytoplankton bloom (Saydam, 1996; Saydam *et al.*, 1998). Hence, the relationship between atmospheric supply of iron to the sea surface and biological response was subject of various studies (Faust, 1994; Dulac *et al.*, 1996; Johnson *et al.*, 1997; Boyle, 1997).

IMPACT ON THE NORTHERN ADRIATIC

Atmospheric inputs of trace elements and potential pollutants have already been studied in the Adriatic (Guerzoni *et al.*, 1999a) and dust mineral signature in sediments in the Adriatic has also been reported (Molinaroli, 1996). On the contrary to the other part of the Mediterranean, only few studies on African dust have been made in the northern Adriatic. This is a shallow (mean depth 30 m), semi-enclosed marine basin characterized by limited water mass circulation and significantly higher productivity compared to the oligotrophic areas of the Mediterranean Sea (Pettine *et al.*, 1999). During the summer, when the current system is occasionally modified, the northern Adriatic becomes relatively isolated (closed circulation system prevails) from the remaining parts of the Adriatic Sea (Orlić, 1987). There is an important freshwater inflow, and because of its shallowness the northern Adriatic is subject to highly variable atmospheric forcing. According to the satellite data, Saharan dust reaches the northern Adriatic across the western Mediterranean (mainly over the Sardinia, Corsica and northern Italy or across the Sardinia and Sicily over middle of Italy) and across the Strait of Otranto along the entire Adriatic Sea (Figs. 1 & 2). Most of the desert dust transport over Adriatic seems to occur in early spring and summer. Previous studies indicate that the atmospheric contribution for total phosphorus and orthosilicate was relatively minor in the northern Adriatic (Deggobis & Gilmartin, 1990), but a more detailed study of the atmospheric particle matter input has not been carried out in this area. In their recent study, Giani *et al.* (2001) reported the importance of the downward flux of particulate organic matter in the shallow northern Adriatic basin for the sink and recycling of nutrients and oxygen consumption at the bottom. African dust probably plays a similar role in biogeochemical cycling (in water column and sediment) and in sedimentation of the particulate matter in the water column of northern Adriatic. The effect of such seasonal dust fallout, which bring nutrients (N, P, Ca, Si) and microelements such as Fe, is expected to be very important for the shallow northern Adriatic. The response of aquatic systems to additions of nutrients is generally an increase of algal biomass, which affects the species composition of phytoplankton assemblages (Conley *et al.*, 1993; Mozetič *et al.*, 1998). Although Saharan dust events exhibited lower inorganic phosphorus solubility in seawater, these episodes may still contribute high load phosphorous concentration to the surface waters according to their relatively high deposition raates and high total inorganic phosphorous concentrations (Herut *et al.*, 1999). In P-limited waters of the northern Adriatic (Chiaudani & Vighi, 1982; Maestrini *et al.*, 1997), particular dust event may cause an imbalance of N:P and trigger off a development of algal blooms. Moreover, the deposition of Saharan dust may alleviate iron limitation, which could be determinant for algal blooms, including harmful ones. Mineral dust particles may be also involved in scavenging and aggregation processes of organic matter or they can serve as substratum for plankton organisms.

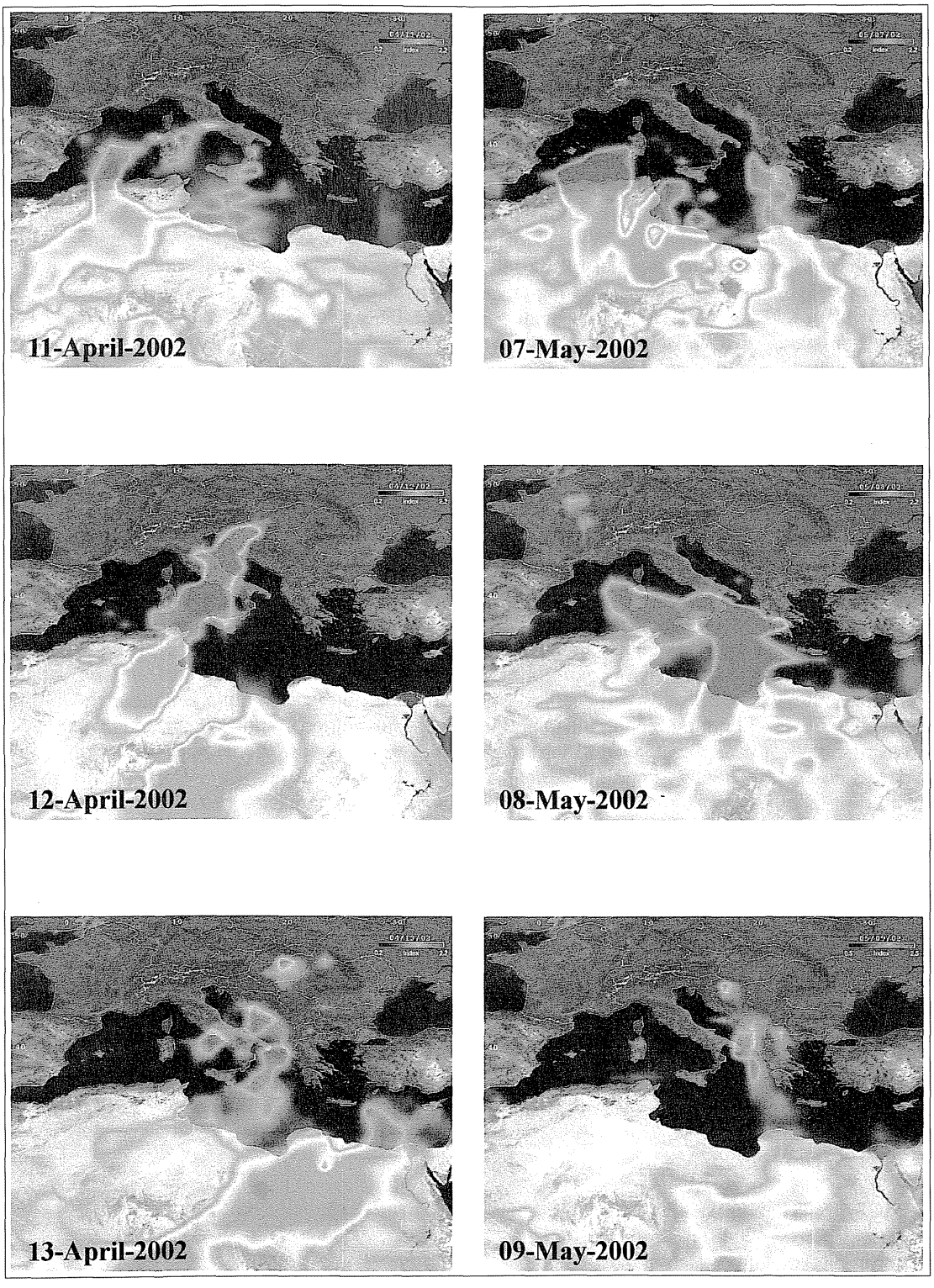


Fig. 2: Images from NASA's satellite based Total Ozone Mapping Spectrometer (TOMS) showing an African dust event over the Mediterranean and Adriatic Sea in April and May of 2002 (Photo courtesy Laboratory for Atmospheres TOMS Project, NASA Goddard Space Flight Center).
Sl. 2: Satelitski posnetki (Total Ozone Mapping Spectrometer - TOMS) vnosa afriškega peska v Sredozemsko in Jadransko morje v mesecu aprilu in maju 2002 (z dovoljenjem: Laboratory for Atmospheres TOMS Project, NASA Goddard Space Flight Center).

CONCLUSIONS

Bearing in mind, a) that atmospheric inputs of metals and nutrients to the Mediterranean appear to be of a similar magnitude to fluvial inputs and that atmospheric supply of several trace elements (total and dissolved input of these elements) and potential pollutants are very important for the Mediterranean and northern Adriatic (Guerzoni *et al.,* 1999a), b) that Saharan dust (containing minerals, nutrients, trace elements and pollutants) frequently reaches the northernmost part of the Mediterranean, c) the complexity of Adriatic (Cushman-Roisin *et al.,* 2000), and d) the lack of monitoring of African dust transport to the northern Adriatic, the future work is needed to provide basic information and estimation of atmospheric inputs.

In order to get more insight into the role of Saharan outbreaks in the northern Adriatic, a multidisciplinary research should be planned for the future in this area. Information such as dust transport (meteorology, mass trajectories), deposition and chemistry of supplied material are needed for better understanding of the impact and magnitude of dust inputs in biogeochemical cycles in the entire Adriatic, as well as in its sub basins (northern Adriatic, Gulf of Trieste).

ACKNOWLEDGEMENTS

I would like to thank Dr. Jay R. Herman, Principal Investigator for TOMS Aerosol/UV projects and Ozone Processing Team at NASA/Goddard Space Flight Center for permission and possibility to use TOMS images. My sincere thanks go to Mr. T. Makovec for his help in preparing figures.

VPLIV VNOSA AFRIŠKEGA PESKA V SEVERNI JADRAN

Nives KOVAČ
Morska biološka postaja, Nacionalni inšitut za biologijo, SI-6330 Piran, Fornače 41

POVZETEK

Vnos snovi (naravnega in antropogenega izvora) preko atmosfere ima pomemben vpliv na morsko okolje. Glavni vir naravnih atmosferskih delcev, vnešenih v Mediteransko morje, je afriški pesek, pogosto imenovan "saharski", z izvorom v aridnih in semiaridnih območjih severozahodne Afrike. Prispevek podaja pregled dosedanjih raziskav vnosa afriškega peska v Mediteran in izpostavlja morebitno vlogo tovrstnih vnosov za severni Jadran.

Ključne besede: saharski (afriški) pesek, Mediteran, severni Jadran, atmosferski vnos

REFERENCES

Andreae, M. O. (1996): Raising dust in the greenhouse. Nature 380, 389-390.

Avila, A., Queralt, I., Gallart, F. & Martin-Vide, J. (1996): African dust over Northeastern Spain: Mineralogy and source regions. In: Guerzoni, S. and Chester, R. (Eds): *The Impact of Desert Dust Across the Mediterranean.* Netherlands, Kluwer Academic Publishers, 201-207.

Bergametti, G., Gomes, L., Remoudaki, E., Desbois, M., Martin, D. & Buat-Ménard, P. (1989): Present transport and deposition patterns of African dusts to the northwestern Mediterranean. In: Leinen, M. and Sarnthein (Eds.): NATO ASI series: *Paleoclimatology and Paleometeorology: Modern and Past Patterns of Global Atmospheric Transport,* Kluwer Academic Publishers, New York, 227-252.

Bergametti, G., Remoudaki, E., Losno, R., Steiner, E., Chatenet, B. & Buat-Ménard, P. (1992): Source, transport and deposition of atmospheric aerosol particles over the northwestern Mediterranean. J. Atmos. Chem., 14, 501-513.

Bonelli, P., Braga Marcazzan, G. M. & Cereda, E. (1996): Elemental composition and air trajectories of African dust transported in Northern Italy. In: Guerzoni, S. and Chester, R. (Eds): *The Impact of Desert Dust Across the Mediterranean.* Netherlands, Kluwer Academic Publishers, 275-283.

Boyle, E. (1997): What controls dissolved iron concentrations in the world ocean? A comment. Mar. Chem., 57, 163-167.

Bücher, A., Dubief, J. & Lucas, C. (1983): Retombees estivales de poussieres sahariennes sur l'Europe. Revue de Geologie Dynamique et de Geographie Physique, 24, 153-165.

Carder, K. L., Gregg, W. W., Costello, D. K., Haddad, K. & Prospero, J. M. (1991): Determination of Saharan dust radiance and chlorophyll from CZCS imagery. J. Geophys. Res., 96, 5369-5378.

Carratalà, A., Bellot, J., Gomez, A., & Millan, M. (1996): African dust influence on rainwater on the Eastern coast of Spain. In: Guerzoni, S. and Chester, R. (Eds): *The Impact of Desert Dust Across the Mediterranean.* Netherlands, Kluwer Academic Publishers, 323-332.

Chester, R., Nimmo, M. & Keyse, S. (1996): The influence of Saharan and Middle Eastern desert-derived dust on the trace metal composition of Mediterranean aerosols and rainwaters: An overview. In: Guerzoni, S. and Chester, R. (Eds): *The Impact of Desert Dust Across the Mediterranean.* Netherlands, Kluwer Academic Publishers, 253-273.

Chester, R., Nimmo, M. & Corcoran, P. A. (1997): Rain water-aerosol trace metal relationships at Cap Ferrat: A coastal site in the Western Mediterranean. Mar. Chem., 58, 293-312.

Chiapello, I., Bergametti, G., Chatenet, B., Bousquet, P., Dulac, F. & Santos Soares, E. (1997): Origins of African dust transported over the northeastern tropical Atlantic. J. Geophys. Res., 102, 13, 701-13, 709.

Chiaudani, G. & Vighi, M., (1982): Multistep approach to identification of limiting nutrients in northern Adriatic eutrophied coastal waters. Water Res., 16, 1161-1166.

Conley, D. J., Schelske, C. L. & Stoermer, E. F. (1993): Modification of the biogeochemical cycle of silica with eutrophication. Mar. Ecol. Prog. Ser., 101, 179-192.

Cushman-Roisin B., Gačič M., Paulin P. – M. & A. Artegiani (2000): Oceanography of the Adriatic Sea Past, Present and Future, Dordrecht/Boston/London, Kluwer Academic Publishers, pp. 304.

D'Almeida, G. (1986): A model for Saharan dust transport. J. Climate Appl. Met. 25, 903-916.

De Angelis, M. & Gaudichet, A. (1991): Saharan dust deposition over Mont Blanc (Franch Alps) during the last 30 years. Tellus, 43B, 61-75.

Deggobis, D. & Gilmartin, M. (1990): Nitrogen, phosphorus, and biogenic silicon budges for the northern Adriatic Sea. Oceanol. Acta, 13, 31-45.

Dulac, F., Buat-Menard, P., Ezat, U., Melki, S. & Bergametti, G. (1989): Atmospheric input of trace metals to the western Mediterranean: uncertainties in modelling dry deposition from cascade impactor data. Tellus, 41B, 362-378.

Dulac, F., Moulin, C., Lambert, C. E., Guillard, F., Poitou, J., Guelle, W., Quetel, C. E., Schneider, X. & Ezat, U. (1996): Quantitative remote sensing of African dust transport to the Mediterranean. In: Guerzoni, S. and Chester, R. (Eds): *The Impact of Desert Dust Across the Mediterranean.* Netherlands, Kluwer Academic Publishers, 25-49.

Dulac, F., Hamonou, E., Schneider, X., Moulin, C., Chazette, P., Liberti, G. L., Paronis, D., Lambert, C. E., Legrand, M., Défossez, J., Balis, D., Papayannis, A., Ancellet, G. & Mihalopoulos, N. (1997): METEOSAT and ground-based optical measurments of desert dust within European project MEDUSE. Proc. EUMETESAT Conf., Brussels, 29 Sept. -3 Oct. EUMETSAT, Darmstadt, 549-556.

Faust, B. (1994): Photochemistry of clouds, fogs, and aerosols. Environ. Sci. Technol., 28, 217-222.

Frau, F., Caboi, R. & Cristini, A. (1996): The impact of Saharan dust on trace metal solubility in rainwater in Sardinia, Italy. In: Guerzoni, S. and Chester, R. (Eds): *The Impact of Desert Dust Across the Mediterranean.* Netherlands, Kluwer Academic Publishers, 285-290.

Ganor, E. & Mamane, Y. (1982): Transport of Saharan dust across the Eastern Mediterranean. Atmos. Environ., 16, 581-587.

Ganor, E. & Foner, A. (1996): The mineralogical and chemical properties and the behaviour of aeolian Saharan dust over Israel. In: Guerzoni, S. and Chester, R. (Eds): *The Impact of Desert Dust Across the Mediterranean.* Netherlands, Kluwer Academic Publishers, 163-172.

Giani, M., Boldrin, A., Matteucci, G., Frascari, F., Gismondi, M. & Rabitti, S. (2001): Downward fluxes of particulate carbon, nitrogen and phosphorus in northwestern Adriatic Sea. Sci. Total Environ., 266, 125-134.

Giorgi, F. (1996): Climate modeling over the Mediterranean region: An Overview. In: Guerzoni, S. and Chester, R. (Eds): *The Impact of Desert Dust Across the Mediterranean.* Netherlands, Kluwer Academic Publishers, 1-14.

Guerzoni, S. & Chester, R. (1996): The Impact of Desert Dust Across the Mediterranean, Dordrecht, Netherlands, Kluwer Academic Publisher, pp. 389.

Guerzoni, S., Molinaroli, E. & Chester, R. (1997): Saharan dust inputs to the western Mediterranean Sea: depositional patterns, geochemistry and sedimentological implications. Deep-Sea Res. II, 44, 631-654.

Guerzoni, S., Chester, R., Dulac, F., Herut, B., Loÿe-Pilot, M., Measures, C., Migon, C., Molinaroli, E., Moulin, C., Rossini, P., Sydam, C., Alexandre, S. & Ziveri, P. (1999a): The role of atmospheric deposition in the biogeochemistry of the Mediterranean Sea. Progress in Oceanography, 44, 147-190.

Guerzoni, S., Molinaroli, E., Rossini, P., Rampazzo, G., Quarantotto, G., De Falco, G. & Cristini, S. (1999b): Role of desert aerosol in metal fluxes in the Mediterranean area. Chemosphere 39, 229-246.

Guieu, C., Duce, R. & Arimoto, R., (1994): Dissolved input of manganese to the ocean: aerosol source. J. Geophys. Res. 99, 18789-18800.

Guieu, C. & Thomas, A. J. (1996): Saharan aerosols: from the soil to the ocean. In: Guerzoni, S. and Chester, R. (Eds): *The Impact of Desert Dust Across the Mediterranean.* Netherlands, Kluwer Academic Publishers, 207-216.

Güllü, G. H., Ölmez, I. &Tuncel, G. (1996): Chemical concentrations and elements size distributions of aerosols in the Eastern Mediterranean during strong dust storms. In: Guerzoni, S. and Chester, R. (Eds): *The Impact of Desert Dust Across the Mediterranean.* Netherlands, Kluwer Academic Publishers, 339-347.

Herrmann, L., Jahn, R., & Stahr, K. (1996): Identification and quantification of dust additions in peri-saharan soils. In: Guerzoni, S. and Chester, R. (Eds): *The Impact of Desert Dust Across the Mediterranean.* Netherlands, Kluwer Academic Publishers, 173-182.

Herut, B., Krom, M. D., Pan, G. & Mortimer, R. (1999): Atmospheric input of nitrogen and phosphorus to the Southeast Mediterranean: Sources, fuxes, and possible impact. Limnol. Oceanogr., 44, 1683-1692.

Hjelmroos, M. (1996): Long-range transport of biological particles of desert origin: A short review. In: Guerzoni, S. and Chester, R. (Eds): *The Impact of Desert Dust Across the Mediterranean.* Netherlands, Kluwer Academic Publishers, 247-252.

Houghton, J. T. *et al.* (Eds.): Climate change 1994: Radiative forcing of climate change and evaluation of the IPCC IS92 Emission Scenarios, Cambridge University Press, 1995.

Jickells, T. D. (1999): The inputs of dust derived elements to the Sargasso Sea; a synthesis. Mar. Chem., 68, 5-14.

Johnson, K. S., Gordon, R. M. & Coale, K. H. (1997): What controls dissolved iron concentrations in the world ocean? Mar. Chem. 57, 137-161.

Lenes, J. M., Darrow, B. P., Cattrall, C., Heil, C. A., Callahan, M., Vargo, G. A., Byrne, R. H., Prospero, J. M., Bates, D. E., Fanning, K. A. & Walsh, J. J. (2001): Iron fertilization and the *Trichodesmium* responce on the West Florida shelf. Limnol. Oceanogr., 46, 1261-1277.

Levin, Z. & Ganor, E. (1996): The effects of desert particles on cloud and rain formation in the Eastern Mediterranean. In: Guerzoni, S. and Chester, R. (Eds): *The Impact of Desert Dust Across the Mediterranean.* Netherlands, Kluwer Academic Publishers, 77-86.

Li, X., Maring, H., Savoie, D., Voss, K. & Prospero, J. M. (1996): Dominance of mineral dust in aerosol light-scattering in the North Atlantic trade winds. Nature, 380, 416-419.

Loÿe-Pilot, M. D., Martin, J.-M. & Morelli, J. (1986): Influence of Saharan dust on the rain acidity and atmospheric input to the Mediterranean. Nature, 321, 427-428.

Loÿe-Pilot, M. D. & Morelli, J. (1988): Fluctuations of ionic composition of precipitations collected in Corsica related to changes in the origins of incoming aerosols. J. Aerosol Sci., 19, 577-585.

Loÿe-Pilot, M. D. & Martin, J. M. (1996): Saharan dust input to the Western Mediterranean: An eleven years record in Corsica. In: Guerzoni, S. and Chester, R. (Eds): *The Impact of Desert Dust Across the Mediterranean.* Netherlands, Kluwer Academic Publishers, 191-199.

Maestrini, S. Y., Berland, B. R., Bréret, M., Béchemin, C., Poletti, R. & Rinaldi, A. (1997): Nutrients limiting the algal growth potential (AGP): in Po River Plume and adjacent area, northwest Adriatic Sea: Enrichment biossays with the test algae *Nitzschia closterium* and *Thalassiosira pseudonana.* Estuaries 20, 416-429.

Marticorena, B. & Bergametti, G. (1995): Modeling the atmospheric dust cycle: 1. Design of a soil-derived dust emission scheme. J. Geophys. Res., 100, 16,415-16,430.

Marticorena, B. & Bergametti, G. (1996): Two-year simulations of seasonal and interannual of the Saharan dust emissions. Geophys. Res. Lett., 23, 1921-1924.

Marticorena, B., Bergametti, G., Aumont, B., Callot, Y., N'Doume, C. & Legrand, M. (1997): Modeling the atmospheric dust cycle, 2, Simulation of Saharan dust Sources. J. Geophys. Res., 102, 4387-4404.

Martin, J.-M., Elbaz-Poulichet, F., Guieu, C., Loÿe-Pilot, M. D. & Han, G. (1989): River versus atmospheric input of material to the Mediterranean Sea: an Overview. Mar. Chem., 28, 159-182.

Mihalopoulos, N., Stephanou, E., Kanakidou, M., Pilitsidis, S. & Bousquet, P. (1997): Tropospheric aerosol ionic composition in the Eastern Mediterranean region. Tellus, 49B, 314-326.

Molinaroli, E. & De Falco, G. (1995): Grain size analysis of atmospheric particulates in aerosol and rain collected in Sardinia (Italy). Giornale di Geologia, 57/1-2, 59-65.

Molinaroli, E. & Ibba, A. (1995): Characterization of palygorskite in dust of desertic provenance in aerosols and rain, Sardinia, western Mediterranean. Giornale di Geologia 57/1-2, 67-76.

Molinaroli, E. (1996): Mineralogical characterisation of Saharan dust with a view to its final destination in Mediterranean sediments. In: Guerzoni, S. and Chester, R. (Eds): *The Impact of Desert Dust Across the Mediterranean.* Netherlands, Kluwer Academic Publishers, 153-162.

Molinaroli, E., Pistolato, M., Rampazzo, G. & Guerzoni, S. (1999): Geochemistry of natural and anthropogenic fall-out (aerosol and precipitation): collected from the NW Mediterranean: two different multivariate statistical approaches. Appl. Geochem., 14, 423-432.

Mozetič, P., Turk, V. & Malej, A. (1998): Nutrient enrichment effect on plankton composition. Annales, 13, 31-42.

Moulin, C., Dulac, F., Lambert, C. E., Chazette, P., Jankowiak, I., Chatenet, B. & Lavenu, F. (1997a): Long-term daily monitoring of Saharan dust load over ocean using Meteosat ISCCP-B2 data. 2. Accuracy of the method and validation using Sun photometer measurments. J. Geophys. Res., 102, 16,959-16,969.

Moulin, C., Guaillard, F., Dulac, F., & Lambert, C. E. (1997b): Long-term daily monitoring of Sharan dust load

over ocean using Meteosat ISCCP-B2 data 1. Methodology and preliminary results for 1983-1994 in the Mediterranean. J. Geophys. Res., 102, 16,947-16,958.

Moulin, C., Lambert, C. E., Dulac, F. & Dayan, U. (1997c): Control of atmospheric export of dust from North Africa by the North Atlantic Oscillation. Nature 387, 691-694.

Moulin, C., Lambert, C. E., Dayan, U., Masson, V., Ramonet, M., Bousqquet, P., Legrand, M., Balkanski, Y. J., Guelle, W., Marticorena, B., Bergametti, B. & Dulac, F. (1998): Satellite climatology of African dust transport in the Mediterranean atmosphere. J. Geophys. Res., 103, 13,137-13,144.

Orlić, M. (1987): Oscillations of the inertia period on the Adriatic Sea shelf. Cont. Shelf Res., 7, 577-598.

Pettine, M., Patrolecco, L., Manganelli, M., Capri, S. & Farrace, M. G. (1999): Seasonal variations of dissolved organic matter in the northern Adriatic Sea. Mar. Chem., 64, 153-169.

Prodi, F. & Fea, G. (1979): A case transport and deposition of Saharan dust over Italian peninsula and southern Europe. J. Geophys. Res. 84, 6951-6960.

Prospero, J. M., Nees, R. T. & Uematsu, M. (1987): Deposition rate of dissolved and particulate aluminium derived from Saharan dust precipitation at Miami, Florida. J. Geophys. Res., 92, 14723-14731.

Prospero, J. M. (1996): Saharan dust transport over the North Atlantic ocean and Mediterranean: An overview. In: Guerzoni, S. and Chester, R. (Eds): *The Impact of Desert Dust Across the Mediterranean.* Netherlands, Kluwer Academic Publishers, 133-151.

Remoudaki, E., Bergametti, G. & Losno, R. (1991): On the dynamic of the atmospheric input of copper and manganese into the Western Mediterranean Sea. Atmos. Environ., 25A, 733-744.

Saydam, A. C. (1996): Can we predict harmful algae blooms. Harmful Algae News 15, 5-6.

Saydam, A. C., Polat, I., Girgin, S. & Algün, O. (1998): The impact of desert origin dust on algae blooms. Abstracts Secotox98. International conference on Ecotoxicology and Environmental safety, Antalya, Turkey, 19-21 October 1998, Telli-Karakoç, F. (Ed.), 8, Tubitak, MRC, Energy Systems and Environmental Institute.

Saydam, A. C. & Yilmaz, A. (1998): Dust induced algae growth and Black Sea. International Symposium on Fisheries Ecology, 2-4 September 1998. Trabzon, Turkey.

Saydam, A. C. & Polat, I. (1999): The impact of saharan dust occurence of algal blooms. In: Borrell, M. and Borrell, P. (Eds.): Proceedings of EUROTRAC Symposium '98, Southampton, WIT press, 656-664.

Schulz, M., Balkanski, Y. J., Guelle, W. & Dulac, F. (1998): Role of aerosol size distribution and source location in a three-dimensional simulation of a Saharan dust episode tested against satellite-derived optical thickness. J. Geophys. Res. 103, 10,579-10,592.

Schutz, L. W., Prospero, J. M., Buat-Menard, P., Carvalho, R. C, Cruzado, A., Harris, R., Heidman, N. Z. & Jaenicke, R. (1990): The long-range transport of mineral aerosols: group report. In: Knap, A.H. (Ed.): *The Long-Range Atmospheric Transport of Natural and Contaminant substances,* Kluwer.

Spokes, L. J., Jickells, T. D. & Lim, B. (1994): Solubilisation of aerosol trace metals by cloud processing: A laboratory study. Geochim. Cosmochim. Acta, 58, 3281-3287.

Swap, R., Garstang, M., Greco, S., Talbot, R. & Kallberg, P. (1992): Saharan dust in the Amazon basin. Tellus, 44B, 133-149.

Tegen, I., Lacis, A. A., & Fung, I. (1996): The influence on climate forcing of mineral aerosols from disturbed soils. Nature, 380, 419-422.

Tomadin, L., Wagenbach, D. & Landuzzi, V. (1996): Mineralogy and source of high altitude glacial deposits in the Western Alps: Clay minerals as Saharan dust tracers. In: Guerzoni, S. and Chester, R. (Eds): *The Impact of Desert Dust Across the Mediterranean.* Netherlands, Kluwer Academic Publishers, 223-232.

Vukmirović, Z., Tomasević, M., Unkasević, M., & Tosić, I. (1999): Impact of Saharan dust storms on the territory of Yugoslavia. Balkan Physics Letters, 7, 209-215.

Wagenbach, D., Preunkert, S., Schäfer, J., Jung, W. & Tomadin, L. (1996): Northward transport of Saharan dust recorded in deep Alpine ice core. In: Guerzoni, S. and Chester, R. (Eds): *The Impact of Desert Dust Across the Mediterranean.* Netherlands, Kluwer Academic Publishers, 291-300.

Węgrzynek, D., Jambers, W., Grieken, R. V. & Eisma, D. (1997): Individual particle analysis of Western Mediterranean sediment cores, Rhône suspended matter and Sahara aerosols – Investigation of inputs to the sediment. Mar. Chem., 57, 41-53.

Zhu, X. R., Prospero, J. M. & Millero, F. J. (1997): Diel variability of soluble Fe(II) and soluble total Fe in North African dust in the trade winds at Barbados. J. Geophys. Res. 102, 21,297-21,306.

original scientific paper
received: 2. 7. 2002

UDC 581.5(497.5 Cres)

ECOLOGICAL CHARACTERIZATION OF A MEDITERRANEAN FRESH WATER POOL ON THE MERAG PENINSULA, CRES (CROATIA)

Pamela ZOLDA, Johanna ORTEL & Wolfgang WAITZBAUER
Institute of Ecology and Conservation Biology, University of Vienna, A-1090 Vienna, Althanstraße 14
E-mail: Pamela.Zolda@univie.ac.at

ABSTRACT

In 1997, fauna, flora and water chemistry of a persisting fresh water pool was investigated on the Merag Peninsula of the Kvarner island of Cres. The pond was threatened to become totally covered by Typha angustifolia *L. Different methods to remove parts of the* Typha*-stand have been therefore engaged. Effectiveness of the methods has been controlled qualitatively in the consecutive years 1998-2001. Water chemistry was determined before and after the removal of the phytomass. Two species were new records for the island of Cres:* Orchis laxiflora *Lam., which is endangered throughout the Mediterranean region, and the Water Rail* Rallus aquaticus *L., which was found breeding successfully in the reed belt. Moreover, the water beetle* Hygrobia tarda *(Herbst), a species considered to be extinct in central Europe, was collected.*

Keywords: fresh water pool, fauna, flora, first records, *Typha angustifolia,* floating mat, Cres

CARATTERISTICHE ECOLOGICHE DI UNO STAGNO MEDITERRANEO SULLA PENISOLA DI MERAG, ISOLA DI CHERSO (CROAZIA)

SINTESI

Nel 1997 gli autori hanno studiato la fauna, la flora e le caratteristiche fisico-chimiche dell'acqua di uno specchio d'acqua dolce permanente sulla penisola di Merag dell'isola quarnerina di Cherso. Sullo stagno combeva la minaccia di venir completamente ricoperto da Typha angustifolia *L. Nel tentativo di rimuovere parte della copertura a* Typha *sono stati usati metodi differenti. L'efficacia di tali metodi è stata controllata qualitativamente negli anni consecutivi 1998-2001. Le caratteristiche fisico-chimiche dell'acqua sono state determinate prima e dopo la rimozione della fito-massa. Due specie sono state inoltre segnalate per la prima volta sull'isola di Cherso:* Orchis laxiflora *Lam., minacciata nell'intera regione mediterranea, e il porciglione* Rallus aquaticus *L., che nidificava con successo nel canneto. È stata inoltre raccolta* Hygrobia tarda *(Herbst), specie considerata ormai estinta nell'Europa centrale.*

Parole chiave: specchio d'acqua dolce, fauna, flora, prime segnalazioni, *Typha angustifolia,* intrico galleggiante, Cherso

INTRODUCTION

In semi-arid regions like the Mediterranean, permanent freshwater pools constitute important "cells" that increase the biodiversity of the region. Various species of insects, amphibians, reptiles and waterfowl depend on the pools and the surrounding marsh (Raab *et al.*, 1996; Silveira, 1998). On Cres, more than 70 medium-sized and small pools exist and many of them never dry up (Mavrović, 1994). Some are of natural origin and some are man-made. In the times when the island was more densely populated than today, the Cres inhabitants increased the number of natural pools by artificial ones. Natural or man-made hollows were made impervious by clay. In the past, these pools have been an essential factor in the general water supply particularly for the livestock.

Since the population density has decreased due to migration, livestock has decreased as well. Hence, watering places are used infrequently, they may become heavily infested by cattail and succession to terrestrialisation may start. Since permanent fresh water pools are especially important in semi-arid regions, it is essential to maintain the still existing ones.

The investigated pond of Sveti Vid on the Merag Peninsula was threatened by total coverage of the narrow leafed cattail *Typha angustifolia*, indicating a decreasing utilization and care for the pool by man. The aim of the study was, first of all, to characterize the pool by its flora and fauna in a half-quantitative and qualitative manner in order to document its importance for the local biodiversity. Secondly, it should serve as a basis for finding effective methods to reduce the cattail belt and to achieve the recommended 50:50 ratio of open water and vegetation (Sojda & Solberg, 1993) and to counteract eutrophication (Blab, 1993). This paper shall give the first impression of the life community in and around the pond and studies will be continued in the following years.

MATERIAL AND METHODS

Location of the pool

The pond is situated near the deserted village of Sveti Vid on the Merag Peninsula (Fig.1) and embedded in a formerly intensively cultivated area (vineyards, mulberry trees, laurel groves). Today, the area is only used as sheep pasture. The soil-type is a flat, the stony Terra Rossa and two thirds of the pool are surrounded by stonewalls at a distance of 3-5 m, the rest is fenced by a wire net. Shape and exposition are shown in Fig. 2. Water samples for chemical analysis were taken 30 cm below the water surface and parameters were determined using a Merck outdoor Test (Art. Nr. 111151). Additionally, temperature was measured in the free water-body.

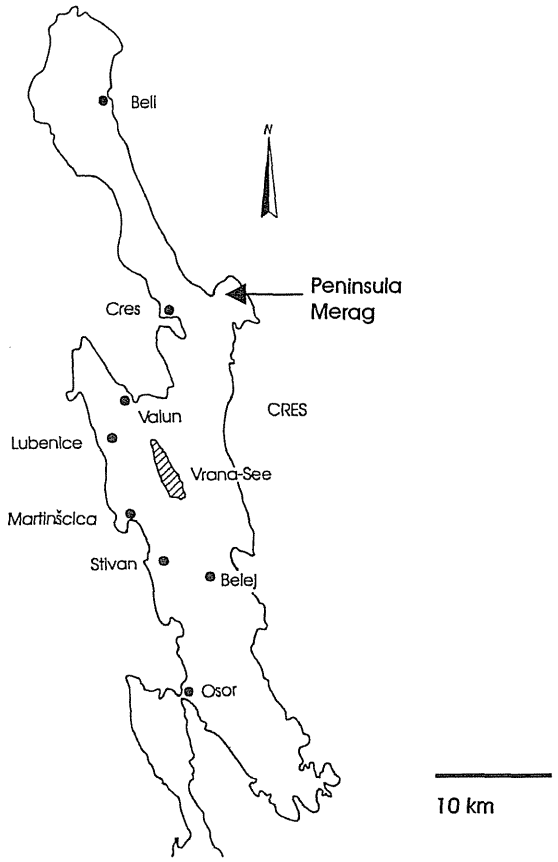


Fig. 1: Study area - location of the Merag Peninsula on the island of Cres (Kvarner, Croatia).
Sl. 1. Raziskovano območje – lokacija Meraškega polotoka na otoku Cresu (Kvarner, Hrvaška).

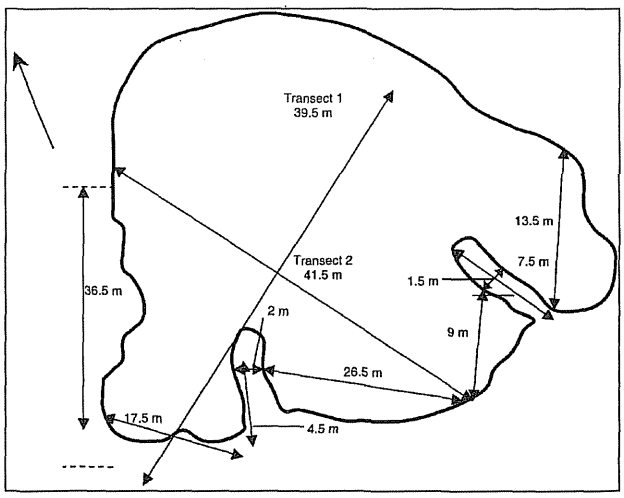


Fig. 2: Dimensions of the pond at Sv. Vid.
Sl. 2: Dimenzije kala pri Sv. Vidu.

——— *Typha* stand before reduction; ------- *Typha* stand after reduction; **x** Dead wood; O *Salix alba*

Salix cinerea; *Ceratophyllum demersum;* *Orchis laxiflora;*

Potamogeton natans

——— *Rogozov sestoj pred skrčenjem;* ------- *Rogozov sestoj po skrčenju;* ***x*** *Plavajoči les*

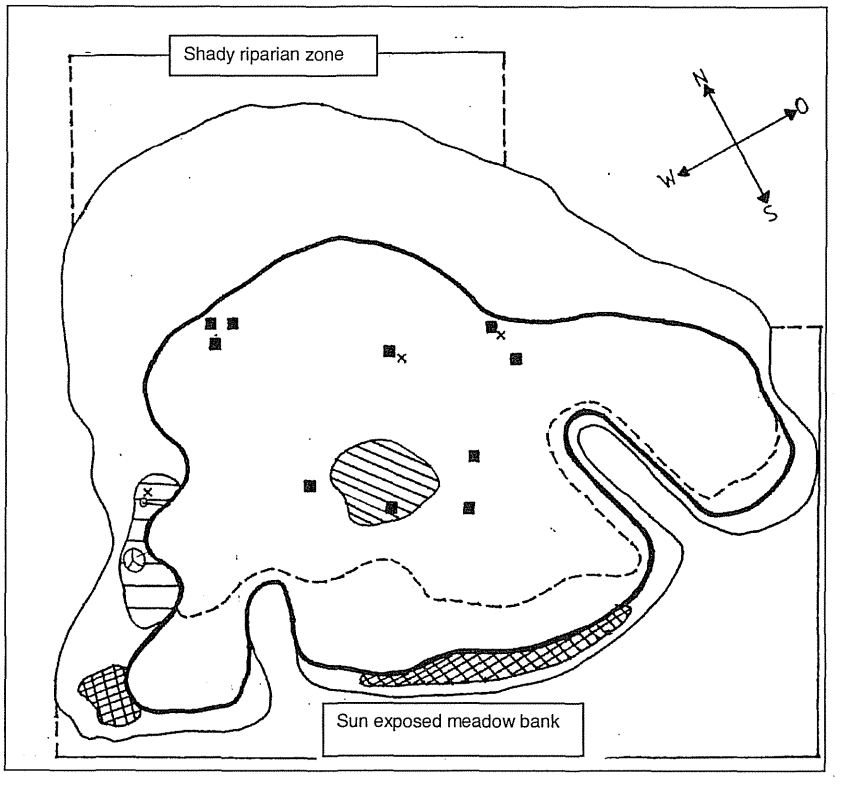


Fig. 3: Sketch of the* Typha *layer before and after reduction of the herbaceous plant layer and woody plants.
Fig. 3: Skica plasti ozkolistnega rogoza pred in po odstranitvi rastlinske mase in olesenelih rastlin.

Tab. 1: Water chemistry of the fresh water pool at Sv. Vid on the Merag Peninsula (Cres Island, Croatia). n.d.= below detection limit of the test, -- not measured.
Tab. 1: Kemijske lastnosti vode v kalu pri Sv. Vidu na Meraškem polotoku (otok Cres, Hrvaška). n.d.= pod mejo detekcije, -- neizmerjene.

	1997		1998	1999		2000		2001
	before *Typha* removal	after *Typha* removal	June	June	September	June	September	May
temperature (°C)	20	21	22.8	--	25	22.5	25.5	20
pH	7.5	7.8	7.5	--	--	7.7	8.5	7.0
oxygen (mg/l)	4.9	3.65	3.0	--	2.0	--	1.7	5.0
phosphate (mg/l)	0.25	0.25	<0.25	--	<0.25	--	0.25	0.25
nitrate (mg/l)	n.d.	0.1	<10	--	10	10	10	0
nitrite (mg/l)	n.d.	n.d.	0.025	--	0.25	0.04	0.3	0
ammonium (mg/l)	0.1	0.2	n.d.	--	n.d.	--	0.2	0.1
total hardness (°dH)	17.1	15.2	18.1	--	--	18.4	18.1	14.7
carbonate hardness (°dH)	17	15.5	16.4	--	--	--	16.8	4.6
residual hardness (°dH)	>0.5	>0.5	>0.5	--	--	--	> 0.5	--

Vegetation

Vegetation within and around the pool was recorded. The marsh flora was investigated along two transects (Fig. 2). For the reduction of the cattail, the *T. angustifolia* stems rooting in the bottom of the pond near the shore were either pulled out by hand or cut below the water surface due to damage rhizomes infiltrated by water. A part of the floating rhizome mat in the centre of the pond was sawed into squares and, after estimating its biomass, removed from the water (Fig. 4a). The development of the *Typha* layer was documented photographically in spring and autumn/winter from 1997 to 2001.

Fauna

The fauna associated with the pond was recorded qualitatively considering the different habitats: free water body, benthos, *Typha*-stand (standing crop and floating mat). Population densities of two vertebrate species were estimated for an area of about 250 m^2: *Gambusia affinis* was caught in a constrained area for 30 min by hand nets. Projection of the number of individuals caught yielded an estimation for the total population size. Population density of *Rana ridibunda* was estimated by observing the sunny shore of the pond for several times during June 2^{nd} – 14^{th} 1997.

RESULTS AND DISCUSSION

Biotope parameters of the pond

The surface area of the pond is approximately 1,200 m^2 and its maximum depth is 2.18 m. Further dimensions are shown in Figure 2. Water chemistry parameters are summarised in Table 1. The pH value of 7.5 and the low values for nitrate and nitrite indicate rather good water quality. Removing of *Typha* did not influence water chemistry neither immediately nor in longer term. Slight differences between the years may be due to differences in water level and temperature: during the season, the water level of the pool changed between high water after winter rainfall and extensive desiccation during the summer. Seasonal fluctuations between 130 cm and 170 cm are apparently normal. During the study period, the highest water level in the pool of Merag rose up to approximately 215 cm (November 1998, see also Fig. 4f) and the lowest level fell down to 40 cm (August 2000, see also Fig. 4j). Under the extreme summer conditions, the water line could recede along the East-West-line down to 9.5 m from the shore with a reduction of the water volume of about 85%. At that time, it is particularly the fish population that gets very crowded in the highly restricted zone of life.

Tab. 2: List of the most abundant plant species growing on the Typha-rhizome mat in the fresh water pool at Sv. Vid on the Merag Peninsula (Cres Island, Croatia). Tab. 2: Seznam najštevilnejših rastlinskih vrst, rastočih na plavajočem rogozu v kalu pri Sv. Vidu na Meraškem polotoku (otok Cres, Hrvaška).

Bryophyta	*Calliergonella cuspidata* *Aulacomnium palustre* *Plagiomnium undulatum* *Drepanocladus aduncus*
Ranunculaceae	*Ranunculus lingua*
Cyperaceae	*Carex sylvatica* *Carex* cf. *acutiformis* *Carex vulpina*
Typhaceae	*Typha angustifolia*
Rubiaceae	*Galium album*
Rosaceae	*Potentilla reptans*
Polygonaceae	*Rumex conglomeratus*
Salicaceae	*Salix cinerea* *Salix alba*
Orchidaceae	*Orchis laxiflora*
Asteraceae	*Eupatorium cannabinum* *Pulicaria dysenterica*
Onagraceae	*Epilobium hirsutum*

Very low water does not only cause general problems for the aquatic fauna, it also influences the ecological balance by changes of the hydrochemical and – physical life conditions, especially by a low rate of oxygen combined with high water temperatures (Tab. 1). The water surface in the summer is also covered with a dense algae mat (see also Fig. 4i), which hinders the exchange of oxygen. Values for ammonium (0.1-0.2 mg/l) and oxygen indicate a water quality of 2-3 and this corresponds to the occurrence of *Potamogeton natans* and *Ceratophyllum demersum* (Bellmann, 1988) The presence of *Potamogetum natans* indicates β-mesosaprobe water quality (Streble & Krauter, 1988) and *Ceratophyllum demersum* is typical for eutrophic shallow waters and a resistant species of eutrophic lakes (Toivonen & Bäck, 1989).

Phosphor rates of 0.05 mg/l are considered critical. The measured phosphate and nitrite values of 0.25 mg/l in autumn 1999 and 2000 are relatively high and may result from a sheep cadaver, which was found lying in the water in the autumn.

Vegetation

The northern shore of the pool is shaded by trees of *Acer campestre* and *A. monspessulanum*, whereas the southern shore is treeless and heavily grazed by sheep. Typical herbs of this sun-exposed area are: *Stachys erecta, Marrubium peregrinum, Galactites tomentosa,*

Tab. 3: Animalcommunity associated with the permanent fresh water pool at Sv. Vid.
Tab. 3: Živalska združba, povezana s sladkovodnim kalom pri Sv. Vidu.

Gastropoda	Acroloxidae	*Acroloxus lacustris*
Araneae	Lycosidae	*Pirata* sp.
	Tetragnathidae	*Tetragnatha* sp.
Odonata	Coenagrionidae	*Coenagrion puella*
		Coenagrion scitulum
		Ceriagrion tenellum
		Ischnura elegans
		Enallagma cyathigerum
	Aeshnidae	*Anax imperator*
	Libellulidae	*Orthetrum cancellatum*
		Crocothemis erythraea
		Libellula depressa
Ensifera	Gryllotalpidae	*Gryllotalpa gryllotalpa*
	Gryllidae	*Pteronemobius heydeni*
	Tettigonidae	*Pholidoptera littoralis*
Caelifera	Acrididae	*Aiolopus strepens*
Heteroptera	Notonectidae	*Notonecta* sp.
	Nepidae	*Nepa* sp.
Coleoptera	Carabidae	*Oodes helopioides*
	Dytiscidae	*Cybister laterimarginalis*
		Noterus sp.
		Scirtes sp.
		Cyphon sp.
	Hygrobiidae	*Hygrobia tarda*
	Hydrophilidae	*Enochrus testaceus*
Diptera	Stratiomyidae	*Stratiomys longicornis*
		Stratiomys. potamida
		Lasiopa villosa
		Odontomyia ornata
	Syrphidae	*Eristalis similis*
		Eurimyia lineata
Pisces	Poeciliidae	*Gambusia affinis*
Amphibia	Hylidae	*Hyla arborea*
	Ranidae	*Rana ridibunda*
Reptilia	Lacertidae	*Podarcis melisellensis*
	Colubridae	*Natrix natrix*
		Elaphe situla
		Elaphe quatuorlineata
Aves	Rallidae	*Rallus aquaticus*

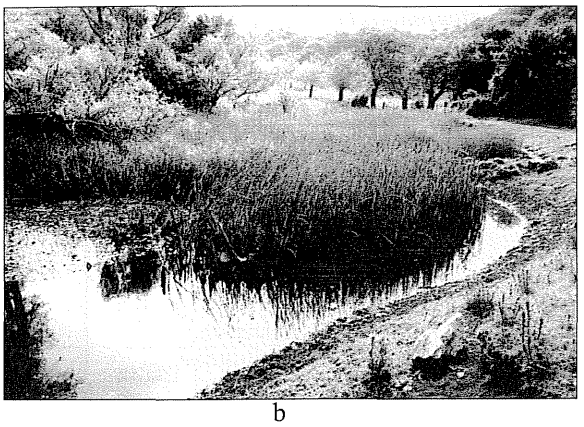
Plantago media, Trifolium repens, Dactylis glomerata. Willows (*Salix alba, S. cinerea*) of 0.3 m (min.) to 2.75 m (max.) circumference grow in the northern part of the pool (Fig. 3).

About three quarters of the water surface were covered by *T. angustifolia*, the rest of the surface partly by *Potamogetum natans* and *Ceratophyllum demersum* (Fig. 3). In the centre of the pond, *T. angustifolia* forms a floating rhizome mat on which marsh flora is growing (Tab. 2). The mat of the cattail has its maximum thickness in the central part, which suggests that it originated in the centre of the pool, and expands towards the shore. Since the mat works as a physical and chemical filter (Ennabili *et al.*, 1998), other plant species were found in a characteristic distribution pattern. However, factors like light condition, interspecific competition and nutrient supply may also be responsible.

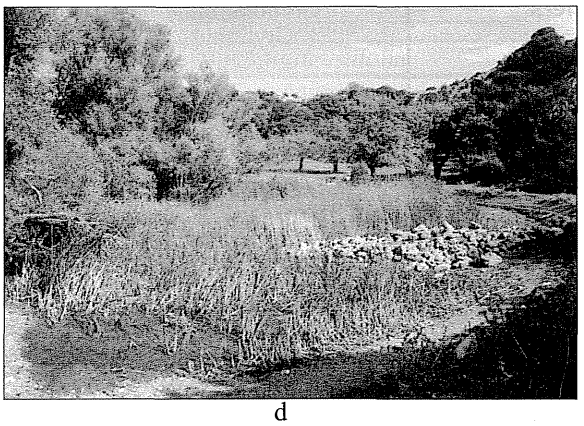
All four recorded moss-species are widely distributed and typical for marshy habitats. *Aulacomnium palustre* is typical for weakly to strongly acidic bogs (Frahm & Frey, 1983; Jahns, 1987). *Epilobium hirsutum* is typical of terrestrialisation communities and eutrophic species like *Rumex conglomeratus, Pulicaria dysenterica* and *Eupatorium cannabium* indicate nitrification.

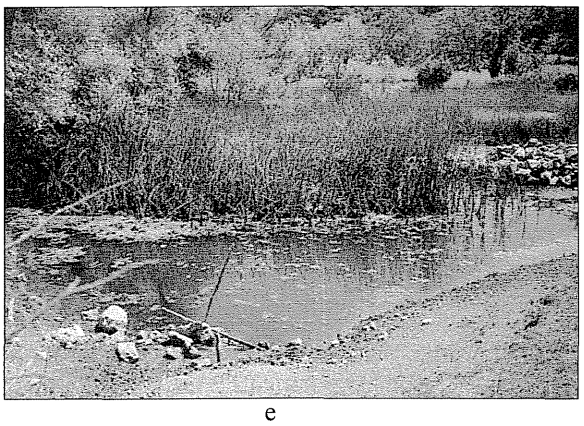
Noteworthy is the first record of *Orchis laxiflora* on the island of Cres. This endangered orchid is distributed throughout the northern Mediterranean, but rare due to loss in habitats (Baumann & Künkele, 1982). In 1997, the population of 150-200 individuals bloomed in the centre of the rhizome mat. From 1998 to 2000, no orchids were found blooming. This may be due to sheep grazing in the central part of the *Typha*- stand during the low water level. In May 2001, around 150 orchids were found blooming again.

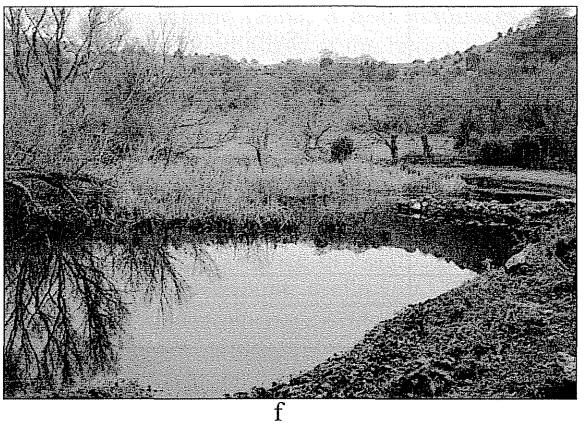

a

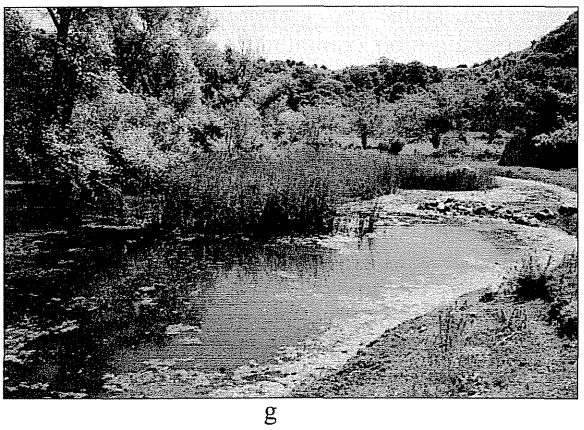

b

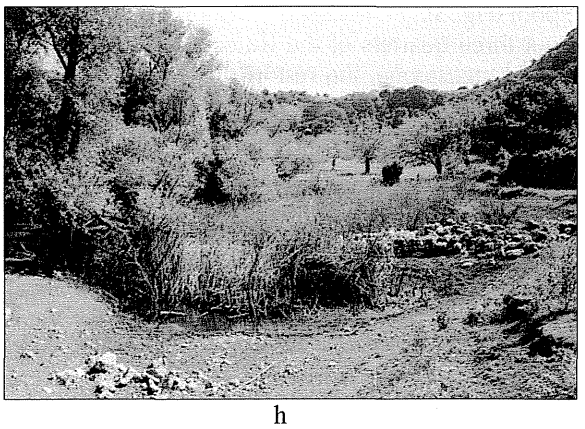

c


d


e


f


g


h

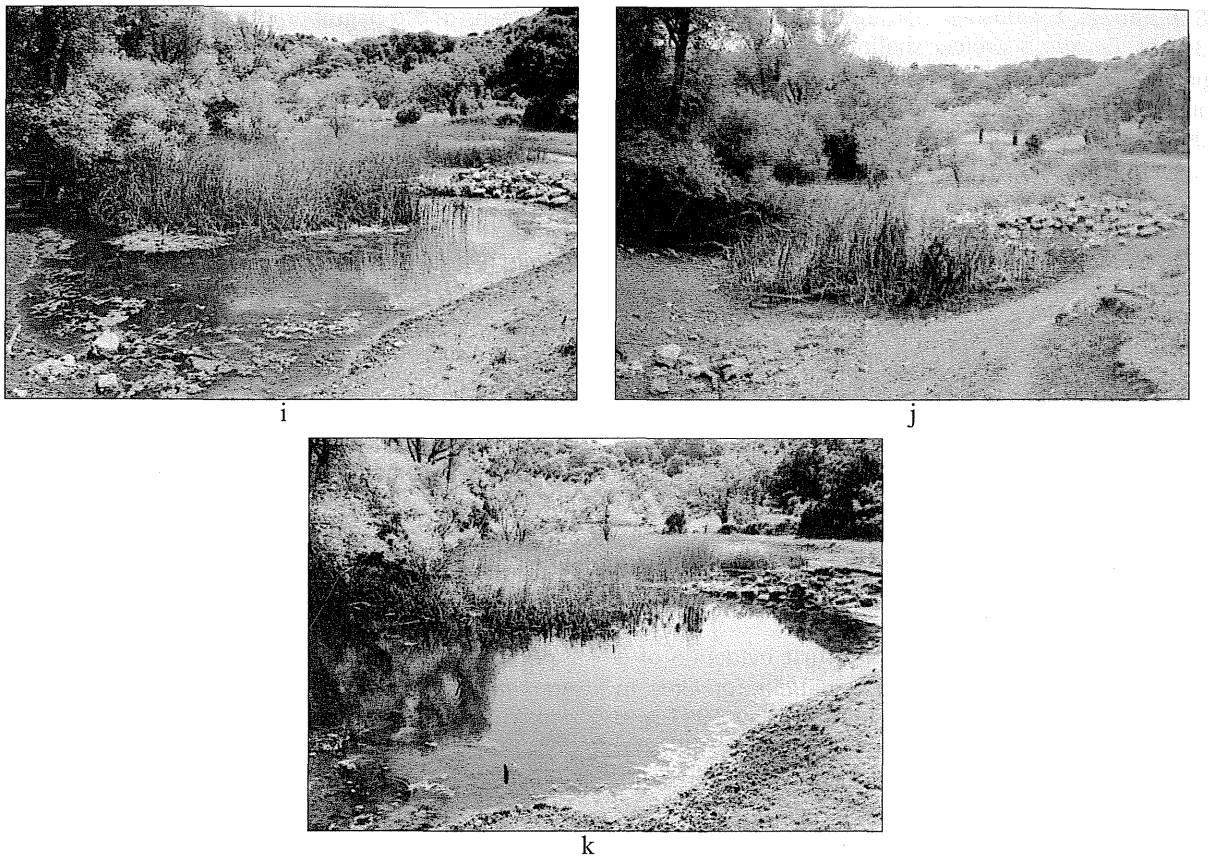


Fig. 4: Documentation of the removal of the cattail belt and its recovery in 4 consecutive years at the pond at Sv. Vid, Merag:
a. removal of the rhizome; b. *Typha* ***stand before reduction in spring 1997; c.*** *Typha* ***stand after reduction in spring 1997; d. autumn 1997; e. spring 1998; f. winter 1998; g. spring 1999; h. autumn 1999; i. spring 2000; j. autumn 2000; k. spring 2001.***
Sl. 4: Dokumentacija o odstranitvi pasu ozkolistnega rogoza in njegovi ponovni rasti v 4 zaporednih letih v kalu pri Sv. Vidu na Meraškem polotoku:
a. odstranitev rizoma; b. sestoj ozkolistnega rogoza pred krčenjem spomladi 1997; c. sestoj ozkolistnega rogoza po krčenju spomladi 1997; d. jesen 1997; e. pomlad 1998; f. zima 1998; g. pomlad 1999; h. jesen 1999; i. pomlad 2000; j. jesen 2000; k. pomlad 2001.

Typha

During the last years, the open surface of the pond decreased dramatically due to the expansion of *T. angustifolia*. Total coverage would threaten the existence of the pond. Therefore it was decided to remove some parts of the cattail belt. Just by doing that, it was discovered that the centre of the *Typha*-stand consisted of a floating rhizome mat. The original margins of the *Typha*-stand and the margins after removing the cattail are given in Figure 3. Cattail rooting near the shore was pulled out by hand or cut beneath the water surface and about 25 m^2 of the floating mat with an average thickness of 40 cm, which corresponds to a biomass of 5.1 t fresh weight (3.1 t dry weight), were removed. Controls in the following years (1998-2001) showed that the rhizome layer did not expand where it had been cut (see also Fig. 4). In September 1997, only cattails removed by hand sprouted again, whereas nearly none recovered amongst those that had been cut below the water line. Hence, the rhizomes may have been damaged by penetrating water. In June 1998, the cattail was cut again and by September 1998 nearly none of the cut cattail had recovered (see Fig. 4f).

Fauna

Gambusia affinis holbrooki (Poeciliidae) was introduced to Europe at the beginning of the 20th century especially for mosquito control (Kinzelbach & Krupp,

1982) and is established throughout S-Europe since 1930. As *G. affinis* prefers shallow sun-exposed water regions, the population density was estimated on the sunny part of the pond. The projection yielded about 5000 individuals/250 m^2 surface of the pool. The population size indicates that even a small body of water exists during the whole year. *G. affinis* is capable to tolerate water temperatures up to 40°C (Al Habbib & Yacoob, 1993), which is far more than the pool temperature measured on several occasions in late spring and in September.

Seven amphibian and twenty-one reptilian species are known for Cres (Sehnal & Schuster, 1999). In total, five species were found at the pond at Sv. Vid (Tab. 3). The abundance of *Rana ridibunda* was estimated, and yielded 20 adults and 3 sub-adults. Several times, individuals of *Natrix natrix* and *Elaphe quatuorlineata* were recorded swimming, whereas 4 juvenile individuals of *E. situla* were observed in the surrounding stone wall. Many specimens of *Podarcis melisellensis* were recorded resting on stones near the shore.

A peculiarity of the pond is the first evidence of a brood of the Water Rail *Rallus aquaticus* for Cres in 1997. Ten eggs hatched successfully in May 1997 and in September of the same year the pond was still used by these birds.

The pool of Sv. Vid is also a life zone of an interesting invertebrate-biocoenosis, which includes common species along with endangered and rare ones (Tab. 3). The fauna of soldier flies (Stratiomyidae) with aquatic larvae feeding on algae is relative rich in species and individuals. *Stratiomys longicornis, S. potamida, Lasiopa villosa* and *Odontomyia ornata* were recorded. High numbers of larvae of Stratomyidae were found in the benthos. The maggots of two species of hover flies, *Eristalis similis* (= *E. pratorum)* and *Eurimyia lineata*, were found developing in the pond.

The largest dytiscid beetle is *Cybister laterimarginalis*. This species occurs in lakes with deep water and is not common in Europe with tendency to recede (Schmidl, 1995). Remarkable is the presence of *Hygrobia tarda* (Hygrobiidae), the only species of this water beetle family in Europe, which is considered to be extinct in Central Europe (Sondermann, 1990). Both species were also found near Osor (Franciscolo, 1978).

High numbers of *Gryllotalpa gryllotalpa* in different developmental stages escaped from the *Typha*-rhizome mats, which were removed from the pond. Several specimens of the hygrophilic and warm loving (Ingrisch & Kohler, 1998) grasshoppers *Pteronemobius heydeni* and *Pholidoptera littoralis* were also found near the water.

Twenty-one dragonfly species are known from the island of Cres (Sušić & Perinčić, 2000), 9 of which were identified at the pond of Sv.Vid (Tab. 3). Typical Mediterranean species like *Coenagrion scitulum, Ceriagrion tenellum* and *Crocothemis erythraea,* which also was abundant as larvae in the benthos, occur with species distributed throughout Middle Europe like *Enallagma cyathigerum* and *Ischnura elegans. Ceriagrion tenellum* is abundant in the Mediterranean region and mostly found along flowing waters, whereas *C. scitulum* is considered to be rare throughout its distribution area (Bellmann, 1993). The same author often reported *C. scitulum* from very small, densely vegetated pools, which were rather isolated in a dry landscape of Istria. The fauna of freshwater snails is very poor and only *Acroloxus lacustris* was found in a small population under stones along the shore and within the cattail belt. Especially the appearance of the Emperor Dragonfly *Anax imperator,* a species that is missing at desiccating ponds (Bellmann, 1993), is an evidence that the pool does not dry up during the year.

CONCLUSIONS

The pond at Sv. Vid was heavily threatened to dry up completely due to the extensive growth of the *Typha* rhizome. During our investigations, this pool showed to be an important cell of biodiversity within the old cultivated area. This was underlined by the first records of two species for the island of Cres. Furthermore, a remarkable number of endangered and rare plant and animal species live around or in the pond. The removal of the *Typha* rhizome was apparently the right way to save the water level and to guarantee the existence of the water body for many years. A continuation of the described management would be desirable.

ACKNOWLEDGEMENTS

We wish to thank all the students from the University of Vienna, who attended the ecological courses on Cres and helped with the acquisition of some data, and Dr. Goran Sušić from the Ekocentar, Beli for providing facilities for our research.

EKOLOŠKE ZNAČILNOSTI SREDOZEMSKEGA KALA NA MERAŠKEM POLOTOKU NA OTOKU CRESU (HRVAŠKA)

Pamela ZOLDA, Johanna ORTEL & Wolfgang WAITZBAUER
Institute of Ecology and Conservation Biology, University of Vienna, A-1090 Vienna, Althanstraße 14
E-mail: Pamela.Zolda@univie.ac.at

POVZETEK

Leta 1997 so avtorji članka na Meraškem polotoku na otoku Cresu raziskovali favno, floro in fizikalne ter kemijske lastnosti vode v kalu, ki ga je čedalje bolj preraščal ozkolistni rogoz Typha angustifolia *L. To je bil razlog za odločitev, da se z različnimi metodami poskusi odstraniti rogozov sestoj. Učinkovitost metod je bila kvalitativno nadzorovana med letoma 1998 in 2001. Fizikalne in kemijske lastnosti vode so bile ugotovljene pred in po odstranitvi rastlinske mase. Sicer pa sta bili na otoku Cresu odkriti dve novi vrsti:* Orchis laxiflora *Lam., ki je ogrožena v celotni sredozemski regiji, in mokož* Rallus aquaticus *L., ki je uspešno gnezdil v trstičevju. Poleg tega je bil odkrit tudi potapnik* Hygrobia tarda *(Herbst), za katerega domnevajo, da je v Srednji Evropi že izumrl.*

Ključne besede: kal, favna, flora, prvi podatki, *Typha angustifolia,* plavajoče rastlinje, Cres

REFERENCES

Al Habbib, O. A. M. & M. P. Yacoob (1993): Effects of acclimatation and experience to changing heat and cold shock temperature on lethal temperature and thermal tolerance of *Gambusia affinis* (Baird and Girard) (Poeciliidae). Cybium, 17(4), 265-272.

Baumann, H. & S. Künkele (1982): Die wildwachsenden Orchideen Europas. Kosmos-Verlag, Franckh, Stuttgart, 432 pp.

Bellmann, H. (1988): Leben in Bach und Teich. Mosaik Verlag, München, 287 pp.

Bellmann, H. (1993): Libellen. Beobachten, bestimmen. Verlag J. Neumann, 272 pp.

Blab, J. (1993): Grundlagen des Biotopschutzes für Tiere. Kilda Verlag, Bonn, 479 pp.

Ennabili, A., M. Ater & M. Radoux (1998): Biomass production and NPK retention in macrophytes from wetlands of the Tingitan Peninsula. Aquatic Botany, 62(1), 45-56.

Frahm, J. P. & W. Frey (1983): Moosflora. Ulmer Verlag, Stuttgart, 528 pp.

Franciscolo, M. E. (1978): Hydradephaga of Yugoslav Adriatic Islands – Part II. Cres, Lošinj and Unije. Acta ent. Jug., 14, 35-47.

Ingrisch, S. & G. Köhler (1998): Die Heuschrecken Mitteleuropas. Westarp-Wiss., Magdeburg, 460 pp.

Jahns, H. M. (1987): Farne, Moose, Flechten. Mittel-, Nord und Westeuropas. 3. Auflage, München, Wien, Zürich, BLV Verlagsgesellschaft, 255 pp.

Kinzelbach, R. & F. Krupp (1982): Zur Einbürgerung des Moskitofisches (*Gambusia affinis*) in Mitteleuropa. Mainzer Naturwissenschaftliches Archiv, 20, 67-77.

Mavrović, N. (1994): Cres und Lošinj. Wanderungen über Inseln, Eilande und Riffe. Art Studio Azinović, Zagreb, 184 pp.

Raab, R., A. Chovanec & A.K. Wiener (1996): Aspects of habitat selection by adult dragonflies at a newly created pond in Vienna, Austria. Odonatologica, 25(4), 387-390.

Schmidl, J. (1995): Beitrag zur Faunistik und Ökologie nordbayerischer Hydradephaga (Coleoptera: Dytiscidae, Haliplidae). NachrBl. bayer. Ent., 44(3/4), 64-69.

Sehnal, P. & A. Schuster (1999): Herpetologische beobachtungen auf der Kvarnerinsel Cres, Kroatien. Ergebnisse von 5 Exkursionen. Herpetozoa, 12(3/4), 163-178.

Silveira, J. G. (1998): Avian use of vernal pools and implications for conservation practice. In: Witham, C.W., E. T. Bauder, D. Belk, W. R. Ferren & R. Ornduff (eds.): *Ecology, Conservation and Management of Vernal Pool Ecosystems.* Proceedings from a 1996 Conference, California Native Plant Society, Sacramento, CA, p. 92-106.

Sojda, R. S. & K. L. Solberg (1993): Management and control of cattails. U. S. Fish and Wildlife Leaflet 13.4.13.

Sondermann, W. (1990): Zur Ökologie und Faunistik der in der Umgebung von Bremen vorkommenden Schwimmkäfer (Dytiscidae) sowie von *Hygrobia tarda*. Abh. Naturw. Ver. Bremen, 41(2), 131-152

Streble, H. & D. Krauter (1988): Das Leben im Wassertropfen. 8. Auflage. Franck´sche Verlagshandlung, Stuttgart.

Sušić, G. & T. Perinčić (2000): History and art in the nature. Guide through the educational path. Stoza Tramuntana I.

Toivonen, H. & S. Bäck (1989): Changes in aquatic vegetation of a small eutrophicated and lowered lake (southern Finland): Ann. Bot. Fennici, 26, 27-38.

FAVNA

FAUNA

FAUNA

izvirni znanstveni članek
prejeto: 13. 7. 2002

UDK 598.2:633.2.03(497.4-14)

POPIS GNEZDEČIH PTIC NA PLANOTI MED GOLIČEM, LIPNIKOM IN KAVČIČEM (ČIČARIJA, SLOVENIJA)

Iztok GEISTER
Zavod za favnistiko Koper, SI-6276 Pobegi, Sv. Anton, Kocjančiči 18

IZVLEČEK

V juniju 2002 je bilo na travnati planoti med Goličem, Lipnikom in Kavčičem v Čičariji popisanih 35 vrst ptic. Najpogostejša gnezdilka je poljski škrjanec Alauda arvensis. *Na cca 500 ha veliki površini je bilo popisanih 81 pojočih samcev. Na planoti gnezdijo med drugim tri vrste ujed: planinski orel* Aquila chrysaetos, *kačar* Circaetus gallicus *in postovka* Falco tinnunculus, *tri vrste strnadov: veliki strnad* Miliaria calandra, *vrtni strnad* Emberiza hortulana *in rumeni strnad* Emberiza citrinella *in tri vrste kur: jerebica* Perdix perdix, *kotorna* Alectoris graeca *in prepelica* Coturnix coturnix. *Po slovenskem rdečem seznamu je osem gnezdilk tega območja uvrščeno v kategorijo prizadetih vrst, deset pa v kategorijo ranljivih vrst.*

Ključne besede: kamniti travnik, popis gnezdečih ptic, pestrost vrst, poljski škrjanec, Slovenska Istra

INVENTARIO DEGLI UCCELLI NIDIFICANTI SULL'ALTIPIANO TRA LE VETTE DI GOLIČ, LIPNIK E KAVČIČ (CICERIA, SLOVENIA)

SINTESI

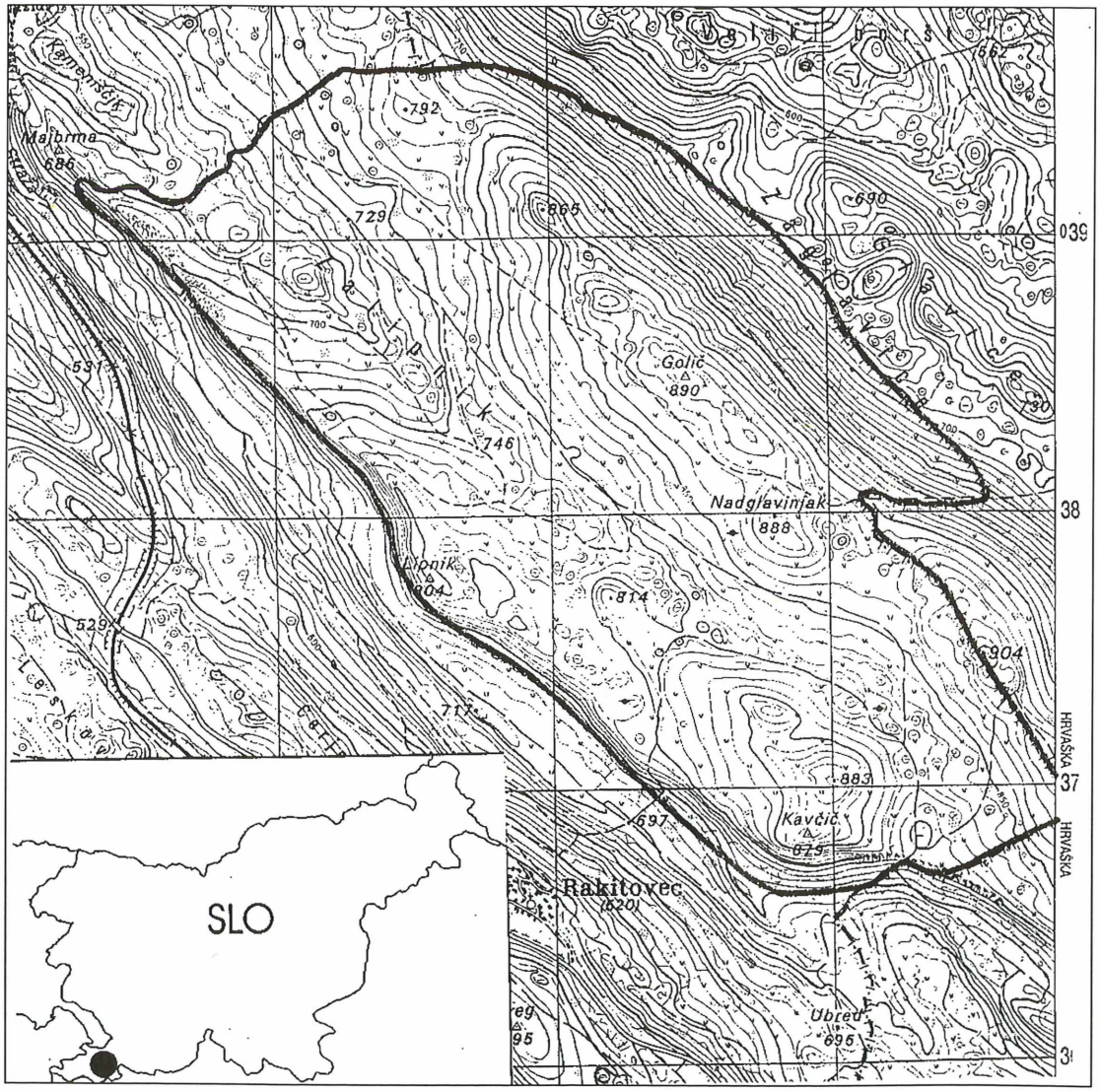
Nel mese di giugno del 2002 è stato fatto l'inventario degli uccelli nidificanti sull'altipiano tra le vette di Golič, Lipnik e Kavčič. Sono state registrate 35 specie. L'allodola, Alauda arvensis, *si è dimostrata essere la specie più frequente. In un'area di circa 500 ettari è stata registrata la presenza di 81 maschi canterini. Sull'altipiano tra l'altro nidificano trè specie di rapaci: l'aquila reale* Aquila chrysaetos, *il biancone* Circaetus gallicus *e il gheppio* Falco tinnunculus, *tre specie di zigoli: lo strillozzo* Miliaria calandra, *l'ortolano* Emberiza hortulana *e lo zigolo giallo* Emberiza citrinella, *nonché tre specie di Fasianidi:* Perdix perdix, Alectoris graeca *e* Coturnix coturnix. *Nella Lista Rossa slovena otto delle specie che nidificano in quest'area vengono considerate minacciate, mentre dieci appartengono alla categoria delle specie vulnerabili.*

Parole chiave: praterie rocciose, inventario degli uccelli nidificanti, varietà di specie, allodola, Istria slovena

UVOD

Planota pod grebenom Kojnik-Žbevnica v Čičariji je razgiban kraški svet kamnitih travnikov s številnimi vrtačami na nadmorski višini med približno 700 in 1000 m. Gorski greben poteka v smeri severozahod-jugovzhod in se proti jugu zvišuje, od Goliča 890 m prek Špičastega vrha (957 m) do Žbevnice (1014 m). Obravnavano območje (Sl. 1) obsega približno polovico planote in je na vzhodu in jugu zamejeno z državno mejo s Hrvaško, na zahodu z ostenjem in na severu s suhim zidom, ki planoto ločuje od območja Kojnika. Tudi v ostenju se nadmorska višina stopnjuje v južni smeri od Majbrme (686 m) prek Lipnika (804 m) do Kavčiča (879 m) (Sl. 2). Z obeh grebenov pada svet v gluho dolino Zalipnik, ki jo proti jugu zapirata dva vrhova: Nadglavinjak (888 m) in 814 m visoki brezimni vrh. Na tem območju sta tudi dve kraški brezni: Jama Podglavinjek in Jama na Boriževih dolinah. Pod planoto leži na severni strani vas Jelovice, na južni pa Rakitovec.

Obravnavano zemljišče je v lasti vaške skupnosti Rakitovec, katerega prebivalci so na planoti še pred nekaj desetletji kosili, pasli drobnico in obdelovali vrtače. Zaradi zastale paše in opuščenega obdelovanja njiv v vrtačah je planota kulturnozgodovinsko opuščena. Zaradi pogostega vetra in občasnih požarov se pustota z izjemo nekoč obdelovanih vrtač ne zarašča. Vendar pustoto naseljujejo številne v Sloveniji redke in ogrožene rastlinske in živalske vrste. Najti je mogoče celo v Sloveniji izgubljene (Wraber, 2002) pa tudi doslej neznane (M. Gogala, *in litt.)* vrste rastlin in živali.



Sl. 1: Popisno območje.
Fig. 1: Survey area.

Kraški pašniki pripadajo združbi nizkega šaša in skalnega glavinca *Carici-Centaureetum rupestris*, travišča na planoti gorski obliki, subasociaciji ozkolistne vilovine *Seslerietosum juncifoliae* (Kaligarič, 1997). V vrtačah pa se zaradi povečane vlažnosti in zakisanosti tal razraščajo visoke steblike, od divjih potonik *Paeonia officinalis*, navadnega zlatega korena *Asphodelus albus*, kojniške perunike *Iris errerhiza* in pokončnega srobota *Clematis recta* do prevladujočega širokolistnega jelenovca *Laserpitium latifolium* v skupni asociaciji *Laserpitietosum*.

Ptice gnezdilke doslej na planoti niso bile popisane, pač pa na bližnjem Kraškem robu (Marčeta, 1994) in na niže ležečem kraškem polju Movraška vala (Geister, *neobj.)* Monografsko so bile opisane ujede in sove Slovenske Istre (Lipej & Gjerkeš, 1994).

METODA

Popisno območje obsega približno 500 ha (Sl. 1). Prevladujejo travniki, z manjšimi kamnitimi izdanki, ponekod nanizanimi v griže; pogoste so vrtače z visokimi steblikami, grmovjem in posameznimi drevesi, na zahodnem obrobju so skalnata pobočja, ki proti jugu preidejo v previsno steno. Popisno območje sega do gozdnega roba (Sl. 3).

Gnezdilke so bile popisane v dneh od 11. 6. do 1. 7. 2002. Dne 12. 6. je bil opravljen tudi nočni popis. Osrednji popis je potekal po petih vzporednih linijskih transektih, v medsebojni oddaljenosti okrog 200 m. Evidentirani so bili predvsem pojoči samci. Po tej metodologiji se pojoči samec, če ni izrecno napisano drugače, šteje kot gnezdeči par. Avtor spremlja ornitofavno tega območja od leta 1994. Zato so v prispevku semtertja omenjeni tudi starejši podatki kot seveda tudi podatki iz spomladanskega obdobja pred intenzivnim popisom v juniju 2002.

REZULTATI

Pregled gnezdik na planoti pod Goličem v letu 2002 je podan v Tabeli 1.

Kačar *Circaetus gallicus*

Odrasla ptica je bila večkrat opazovana tako med nizkim letom nad grebenom kot med pritlehnim letom prek doline z grebena na greben.

Planinski orel *Aquila chrysaetos*

Par planinskih orlov je bil spomladi večkrat opazovan med svatovanjem v zraku. Gnezdo (Sl. 4) je zasedeno vsako četrto leto (zaradi njegove varnosti natančne lokacije gnezda ne navajam). Ob gnezdu so bili najdeni ostanki mladičev srn in divjih prašičev. Zaradi teže plena je gnezdo navadno na nižji nadmorski višini kot lovišče.

Navadna postovka *Falco tinnunculus*

Samec navadne postovke je v obdobju valjenja posedal po izpostavljenih skalah ostenja pri Istrskih vratih. Gnezdo je bilo v votlini, po višini nekje sredi stene. Trije mladiči so se speljali šele sredi julija.

Kotorna *Alectoris graeca*

Par kotorn se je zadrževal na travnatem pobočju pod Istrskimi vrati.

Sl. 2: Pogled s Špičastega vrha na planoto: levo Kavčič, desno Golič, na sredi Lipnik s Koprom v ozadju. (Foto: I. Geister)
Fig. 2: View of the plateau from Špičasti vrh, with Kavčič (on the left), Golič (on the right) and Lipnik (in the middle) with Koper in the background. (Photo: I. Geister)

Sl. 3: Lipov gozd se vzpenja proti Lipniku. (Foto: I. Geister)
Fig. 3: Lime-tree forest rising towards Lipnik. (Photo: I. Geister)

Jerebica *Perdix perdix*

Par jerebic me je dvakrat presenetil na kolovozu, ki se vije po dolini. V glasnem spreletu proti vrtači, obrasli z grmovjem, sem razločno videl rjavo obarvani hrbet in pahljačasto razširjena rdečerjava repna peresa. Četrtega avgusta se je s kolovoza spreletelo poleg odraslih dveh tudi pet mladostnih osebkov.

Prepelica *Coturnix coturnix*

Prepelice se najpogosteje oglašajo ob večernem mraku, vendar jih slišimo tudi zjutraj in čez dan. Na planoti je bilo popisanih 8 pojočih samcev. Proti pričakovanju ne živijo na ravnih tleh, ampak predvsem na pobočjih, ponekod, kot pod vrhom Goliča, celo v izraziti strmini tamkajšne vrtače. Sedemnajstega avgusta se je s kolovoza spreletelo ducat prepelic.

Kukavica *Cuculus canorus*

Samec je bil opazovan pri dvorjenju na drevesu v Zalipniku. Sicer pa je bila kukavica zadnja ptica, ki se je oglašala še tedaj, ko se je dan že prevesil v noč.

Velika uharica *Bubo bubo*

Velika uharica se je oglašala prvega aprila ob sončnem zahodu pod Boriževimi dolinami.

Podhujka *Caprimulgus europaeus*

Na juhozahodnem pobočju od Majbrme do Istrskih vrat se je v juniju oglašalo pet podhujk.

Planinski hudournik *Apus melba*

Ta vrsta hudournika gnezdi sicer nekoliko bolj zahodno od obravnavanega območja, v Jampršniku nad zaselkom Brežec, vendar se ptice med iskanjem hrane spreletavajo tudi ob ostenju vzdolž Lipnika.

Smrdokavra *Upupa epops*

Več smrdokaver se prek celega dne oglaša iz okolice Rakitovca, najbližja pa tista izpod Kavčiča, ki včasih prileti na pevsko mesto v robu stene.

Hribski škrjanec *Lullula arborea*

Proti pričakovanju hribskih škrjancev na planoti tako rekoč ni. Najden je bil le v predelu z nekoliko več drevja, z raztresenimi črnimi bori, v smeri proti Majbrmi.

Poljski škrjanec *Alauda arvensis*

Poljski škrjanec je najpogostejša ptičja vrsta na obravnavanem območju. V juniju 2002 je bilo popisanih 81 pojočih samcev, na travnikih nad ostenjem 9, v dolini 22, in na ovršju 18. Največ pojočih samcev, 32, je bilo popisanih na južnem pobočju osrednjega gorskega grebena. Območni samci radi posedajo po koničastih kamnih, tudi triangulacijskih možicih, narejenih iz kamnov. Opazovanih je bilo tudi več družin speljanih mladičev.

Rjava cipa *Anthus campestris*

Ta vrsta cipe je imela 11. junija speljane mladiče v vrtači ob kolovozu nedaleč od Istrskih vrat.

Drevesna cipa *Anthus trivialis*

Drevesna cipa je sicer dokaj pogosta prebivalka gozdnatega roba ob vznožju planote, še posebno lipovega gozda pod Lipnikom, vendar jo najdemo tudi semterja po vrtačah, tudi na brezimnem travnatem vrhu južno od Goliča, kjer stoji vetromer. Osemnajstega junija je samec neutrudno prepeval na posušenem dva metra visokem drevescu, medtem ko je bilo prvo večje drevo šele v bližnji vrtači.

Sl. 4: Mladič planinskega orla** Aquila chrysaetos **na gnezdu, 23. 6. 2000. (Foto: I. Geister)
Fig. 4: Nestling of the Golden Eagle** Aquila chrysaetos **in the nest on June 23rd 2000. (Photo: I. Geister)

Sl. 5: Slegur** Monticola saxatilis**, Kavčič, 18. 6. 2002. (Foto: I. Geister)
Fig. 5: Rock Thrush** Monticola saxatilis**, Kavčič, June 18th 2002. (Photo: I. Geister)

Prosnik *Saxicola torquata*

Naseljujejo vrtače, zarasle z grmovjem, vendar ni bilo ugotovljenih več kot 5 parov; večina je imela v času popisa mladiče že speljane.

Slegur *Monticola saxatilis*

Samec slegurja je sredi junija po več deset minut posedal po vrhovih drevja in grmovja na pobočju pod Lipnikom. Proti koncu junija pa je drug samec (z manj svetlo belo liso na jurici) skrbel za speljanega mladiča v Istrskih vratih (Sl. 5). Tretji samec je bil opazovan na grižah med Lipnikom in Majbrmo, kjer se je prehranjeval na travniku; dovolil je, da sem se mu približal na 50 m, potem pa se je v pritlehnem letu zavihtel prek skalnega roba.

Kos *Turdus merula*

V vrtačah, poraslih z grmovjem, je bilo popisanih 5 kosov.

Carar *Turdus viscivorus*

Cararji prebivajo v gozdu črnega bora, ki se razteza na celotnem območju Kojnika. Trije osebki so bili popisani na gozdnem robu.

Kratkoperuti vrtnik *Hippolais polyglotta*

Na vročem pobočju Podkavčiča je bil pod ovršjem skalnatega roba popisan pojoči samec tega ptičjega poliglota.

Rjava penica *Sylvia communis*

Sedem pojočih samcev je bilo najdenih v grmovju, ki obraščajo vrtače, eden pa v pritlehnem vrbovju, ki porašča Špičasti vrh.

Črnoglavka *Sylvia atricapilla*

Tudi samci črnoglavke so prepevali v grmovju, ki obrašča vrtače, in tudi njih je bilo sedem.

Plavček *Parus caeruleus*

Kakor drugod po Kraškem robu, tudi na Majbrmi, Lipniku in Kavčiču plavček gnezdi v špranjah skalnatih sten. Spomladi 2002 so bili popisani trije samci.

Velika sinica *Parus major*

Par velikih sinic je še 1. julija nabiral hrano za mladiče v gnezdu v osrednjem predelu planote, medtem ko so se mladiči para pri Istrskih vratih speljali že najmanj tri tedne pred tem.

Rjavi srakoper *Lanius collurio*

V času popisa je na grmovju v vrtačah posedalo 6 samcev rjavega srakoperja. Če so bili sparjeni, so samice še valile, ali pa so bili mladiči še zelo majhni.

Šoja *Garrulus glandarius*

Šoje prihajajo na planoto iz gozda ob njenem vznožju. V času popisa sta bila opažena dva osebka na med seboj odmaknjenih lokalitetah.

Krekovt *Nucifraga caryocatactes*

Štiriindvajsetega avgusta so se trije krehovti prehranjevali na zorečem rumenem drenu v eni izmed vrtač v Zalipniku. Domnevno gnezdijo v okoliških gozdnatih pobočjih.

Ščinkavec *Fringilla coelebs*

Ščinkavec je prebivalec gozda ob vznožju planote. Na sami planoti se ne pojavlja, njegovo petje pa je bilo seveda popisano.

Liščck *Carduelis carduelis*

Družina liščkov s speljanimi mladiči se je konec junija pasla ob kolovozu v dolini planote.

Repnik *Acanthis cannabina*

Družina repnikov s speljanimi mladiči se je sredi junija pasla na ovršju planote.

Rumeni strnad *Emberiza citrinella*

Ta vrsta strnada je na kraškem robu na meji svoje razširjenosti v Sloveniji. En pojoči samec je bil popisan v Zalipniku.

Skalni strnad *Emberiza cia*

Proti pričakovanju na planoti ne gnezdi, pač pa so bili najmanj trije pari najdeni na jugozahodnem z drevjem in grmovjem poraslem skalnatem obrobju.

Vrtni strnad *Emberiza hortulana*

V predelu planote, kjer raztreseno rastejo drevesa črnega bora, so prepevali trije samci vrtnega strnada (Sl. 6). Na nekdanjem pogorišču so bili 11. 6. mladiči enega para speljani, vendar so starši še skrbeli zanje.

Veliki strnad *Miliaria calandra*

Popisanih je bilo 23 pojočih samcev, opazovanih pa je bilo tudi več družin speljanih mladičev. Veliki strnad je tako za poljskim škrjancem druga najpogostejša ptica kamnitih travnikov pod Goličem.

Tab. 1: Pregled gnezdilk na planoti pod Goličem v letu 2002: število popisanih pojočih oziroma teritorialnih samcev, tip prehranjevalnega okolja in tip gnezditvenega okolja.
Tab. 1: A review of birds breeding on the plateau below Golič in 2002: number of surveyed singing or territorial males, type of feeding habitat, and type of nesting habitat.

Vrsta/*Species*	Št. pojočih ali območ. samcev/*No. singing or terr. males*	Prehranjevalno okolje/ *Feeding habitat*	Gnezditveno okolje/ *Nesting habitat*
Kačar *Circaetus gallicus*	1	travnik/*meadows*	gozdni rob/*forest edge*
Planinski orel *Aquila chrysaetos*	1	travnik/*meadows*	skalovje/*rocks*
Navadna postovka *Falco tinnunculus*	1	travnik/*meadows*	skalovje/*rocks*
Kotorna *Alectoris graeca*	1	travnik/*meadows*	skalovje/*rocks*
Jerebica *Perdix perdix*	1	travnik/*meadows*	travnik/*meadows*
Prepelica *Coturnix coturnix*	8	travnik/*meadows*	travnik/*meadows*
Kukavica *Cuculus canorus*	1	travnik/*meadows*	gozdni rob/*forest edge*
Velika uharica *Bubo bubo*	1	travnik/*meadows*	skalovje/*rocks*
Podhujka *Caprimulgus europeus*	2	gozdni rob/*forest edge*	gozdni rob/*forest edge*
Planinski hudournik *Apus melba*	?	ozračje/*air*	skalovje/*rocks*
Smrdokavra *Upupa epops*	1	gozdni rob/*forest edge*	gozdni rob/*forest edge*
Hribski škrjanec *Lullula arborea*	1	travnik/*meadows*	travnik/*meadows*
Poljski škrjanec *Alauda arvensis*	81	travnik/*meadows*	travnik/*meadows*
Rjava cipa *Anthus campestris*	1	travnik/*meadows*	travnik/*meadows*
Drevesna cipa *Anthus trivialis*	6	gozdni rob/*forest edge*	gozdni rob/*forest edge*
Prosnik *Saxicola torquata*	5	travnik/*meadows*	travnik/*meadows*
Slegur *Monticola saxatilis*	3	travnik/*meadows*	skalovje/*rocks*
Kos *Turdus merula*	5	travnik/*meadows*	grmovje/*shrubs*
Carar *Turdus viscivorus*	3	travnik/*meadows*	gozdni rob/*forest edge*
Kratkoperuti vrtnik *Hippolais polyglotta*	1	grmovje/*shrubs*	grmovje/*shrubs*
Rjava penica *Sylvia communis*	8	grmovje/*shrubs*	grmovje/*shrubs*
Črnoglavka *Sylvia atricapilla*	8	grmovje/*shrubs*	grmovje/*shrubs*
Plavček *Parus caeruleus*	3	grmovje/*shrubs*	skalovje/*rocks*
Velika sinica *Parus major*	2	gozdni rob/*forest edge*	gozdni rob/*forest edge*
Rjavi srakoper *Lanius collurio*	6	travnik/*meadows*	grmovje/*shrubs*
Šoja *Garrulus glandarius*	2	gozdni rob/*forest edge*	gozdni rob/*forest edge*
Krekovt *Nucifraga caryocatactes*	1	grmovje/*shrubs*	gozdni rob/*forest edge*
Krokar *Corvus corax*	1	travnik, grmovje	skalovje/*rocks*
Ščinkavec *Fringilla coelebs*	5	gozdni rob/*forest edge*	gozdni rob/*forest edge*
Liščck *Carduelis carduelis*	1	travnik/*meadows*	drevje/*canopy*
Repnik *Acanthis cannabina*	1	travnik/*meadows*	grmovje/*shrubs*
Rumeni strnad *Emberiza citrinella*	1	travnik/*meadows*	gozdni rob/*forest edge*
Skalni strnad *Emberiza cia*	3	gozdni rob/*forest edge*	skalovje/*rocks*
Vrtni strnad *Emberiza hortulana*	3	travnik/*meadows*	gozdni rob/*forest edge*
Veliki strnad *Miliaria calandra*	23	travnik/*meadows*	travnik/*meadows*

RAZPRAVA

V letu 2002 je bilo na planoti med vrhovi Golič, Lipnik in Kavčič popisanih 35 vrst gnezdilk, od tega prevladujejo vrste, ki se prehranjujejo na travniku, le nekaj se jih prehranjuje v grmovju in nekaj na gozdnem robu. Večina od popisanih gnezdilk tudi gnezdi na travniku, nekaj jih gnezdi v grmovju in na drevju ter nekaj v skalovju. Takšen sestav gnezdilk ustreza sestavi habitatov, kjer prevladujejo kamniti travniki, grmovja in drevja pa je največ po vrtačah in seveda na gozdnem robu, ki sega ponekod do skalnatega obrobja, a nikjer do ovršja planote.

Največ (N = 81) je bilo popisanih pojočih samcev poljskega škrjanca *Alauda arvensis*, kar pomeni 1,6 para na 10 hektarjev. Ugotovljena gostota je nizka v primerjavi z gostoto v alpskem sredogorju, kjer znaša na obdelanih tleh 1,8 in na pašnikih 2,0-4,0 para na 10 hektarjev (Schifferli *et al.*, 1980). Gnezditveno območje posameznega para je tako veliko 6,2 ha, kar je znotraj vrednosti, ugotovljenih v alpskem nižavju, kjer so teritoriji veliki od 2,0 do 8,3 ha (Hagemeijer & Blair, 1998). Žal ni razpoložljivih primerjalnih podatkov za suhe travnike drugod v Sredozemlju.

Po številu pojočih samcev je druga najpogostejša vrsta veliki strnad (N = 23), gostota drugih vrst ptic pa je precej manjša; kar sedemnajst vrst je zastopanih z enim samim območnim samcem, domnevno parom. Nizko število osebkov odtehta večja pestrost vrst.

Od pričakovanih vrst pogrešam ptice planinskih pašnikov: repaljščico *Saxicola rubetra*, kupčarja *Oenanthe oenanthe*, in kosca *Crex crex*. Paša je sicer na teh kamnitih travnikih zastala že pred desetletji, toda tehtnejši razlog za odsotnost naštetih vrst je nemara izrazito kserofilni značaj življenjskega okolja. Repaljščica in kupčar sta dokaj pogosta ob selitvi.

Če kje v Sloveniji, potem ravno tu lahko pričakujemo nekatere izginule vrste, kot so kratkoprsti škrjanec *Calandrella brachydactyla*, laški škrjanec *Melanocorypha calandra* in sredozemski kupčar *Oenanthe hispanica*.

Na goliški planoti gnezdi kar nekaj vrst z rdečega seznama (*Odredba o uvrstitvi ogroženih rastlinskih in živalskih vrst v rdeči seznam*, 2002). V kategorijo prizadetih vrst so uvrščene velika uharica *Bubo bubo*, kotorna *Alectoris greaca*, podhujka *Caprimulgus europaeus*, kačar *Circaetus gallicus*, jerebica *Perdix perdix*, smrdokavra *Upupa epops*, rjava cipa *Anthus campestris*, repaljščica *Saxicola rubetra*, vrtni strnad *Emberiza hortulana*, v kategorijo ranljivih vrst pa planinski orel *Aquila chrysaetos*, postovka *Falco tinnunculus*, prepelica *Coturnix coturnix*, hribski škrjanec *Lullula arborea*, poljski škrjanec *Alauda arvensis*, slegur *Monticola saxatilis*, rjava penica *Sylvia communis*, rjavi srakoper *Lanius collurio*, rumeni strnad *Emberiza citrinella* in veliki strnad *Miliaria calandra*.

Sl. 6: Vrtni strnad *Emberiza hortulana*, ***Zalipnik, 11. 6. 2002. (Foto: I. Geister)***
Fig. 6: Ortolan Bunting *Emberiza hortulana*, ***Zalipnik, June 11th 2002. (Photo: I. Geister)***

SURVEY OF THE BIRDS BREEDING ON THE PLATEAU BETWEEN GOLIČ, LIPNIK AND KAVČIČ

Iztok GEISTER
Institute for faunistic survey, SI-6276 Pobegi, Sv. Anton, Kocjančiči 18

SUMMARY

In June 2002, 35 bird species were recorded on the grassy plateau spreading between Golič, Lipnik and Kavčič in the Čičarija region. The most common breeder was Sky Lark Alauda arvensis. *In some 500 ha large area, 81 singing males were registered. On the plateau also breed: three birds of prey species,* i.e. *Golden Eagle* Aquila chrysaetos, *Short-toed Eagle* Circaetus gallicus, *and Common Kestrel* Falco tinnunculus; *three species of Buntings,* i.e. *Corn Bunting* Miliaria calandra, *Ortolan Bunting* Emberiza hortulana, *and Yellowhammer* Emberiza citrinella; *and three gallinaceous species,* i.e. *Grey Partridge* Perdix perdix, *Rock Partridge* Alectoris graeca, *and Common Quail* Coturnix coturnix. *According to the Slovene Red List, eight breeders of this area are listed in the category of affected species, and ten in the category of vulnerable species.*

Key words: stony grassland, breeding birds survey, species diversity, Sky Lark, Slovene Istria

LITERATURA

Hagemeijer, W. J. M. & M. J. Blair (1998): The EBCC Atlas of Breeding Birds. Poyser, London.

Kaligarič, M. (1997): Rastlinstvo primorskega krasa in Slovenske Istre. Annales Majora, Zgodovinsko društvo za južno Primorsko, Koper.

Lipej, L. & M. Gjerkeš (1994): Ujede (Falconiformes) in sove (Strigiformes) slovenske Istre. Annales Ser. Hist. Nat., 4, 53-62.

Marčeta, B. (1994): Stanje in ogroženost gnezdilcev sten črnokalskega kraškega roba. Annales Ser. Hist. Nat., 4, 43-52.

Schifferli, A., P. Geroudet & R. Winkler (1980): Verbreitung der Brutvogel der Schweiz. Schweizerische Vogelwarte Sempach.

Wraber, T. (2002): Utrinka iz istrske flore: učejska bodeča neža in čičarijski dimek. Proteus, 7(64), 306-310.

izvirni znanstveni članek
prejeto: 15. 6. 2002

UDK 595.7(497.4-15)

POJAVLJANJE AFRIŠKEGA MINLJIVCA *HEMIANAX EPHIPPIGER* (BURMEISTER, 1839) NA SLOVENSKEM MORSKEM OBREŽJU (INSECTA: ODONATA)

Iztok GEISTER
Zavod za favnistiko Koper, SI-6276 Pobegi, Sv. Anton, Kocjančiči 18

IZVLEČEK

V drugi polovici aprila 2000 je bilo v Sečoveljskih solinah in v Škocjanskem zatoku (Z Slovenija) opaženih več osebkov obeh spolov afriškega minljivca Hemianax ephippiger. *Dvakrat je bilo opazovano tudi parjenje, vendar kasnejši razvoj ličink in preobrazba nove generacije tega kačjega pastirja nista potrjena.*

Ključne besede: *Hemianax ephippiger*, kačji pastirji, puščavski pesek, občasni gost, morsko obrežje, Slovenija

PRESENZA DI *HEMIANAX EPHIPPIGER* (BURMEISTER, 1839) NELLA FASCIA COSTIERA SLOVENA (INSECTA: ODONATA)

SINTESI

Nelle saline di Sicciole e nella Baia di S. Canziano (Val Stagnon), Slovenia occidentale, sono stati osservati diversi esemplari di entrambi i sessi di Hemianax ephippiger, *nella seconda metà del mese di aprile del 2000. Per due volte è stato inoltre osservato l'accoppiamento, benché non venga confermato lo sviluppo successivo delle larve e la metamorfosi di una nuova generazione di tale libellula.*

Parole chiave: *Hemianax ephippiger*, libellule, sabbia desertica, visitatore occasionale, fascia costiera, Slovenia

UVOD

Afriški minljivec *Hemianax ephippiger* (Burmeister, 1839) iz podreda raznokrilih kačjih pastirjev (Anisoptera) je ena tistih žuželk, ki se naravno razmnožujejo tudi zunaj meja svojega afriško azijskega areala. V posebnih vremenskih razmerah ga močni višinski vetrovi pomladi ali zgodaj poleti prinesejo nad našo celino, kjer se pari in odloži jajčeca, iz katerih se po zelo hitrem razvoju že konec julija in avgusta preobrazi nova generacija. Vse to pa najbrž ne bi bilo mogoče, ko se ta vrsta kačjega pastirja iz družine dev (Aeshnidae) ne bi bila združevala v velike roje in bi ne bila imela svojstvenih lastnosti prilagajanja ter odličnih letalnih sposobnosti. Tako so bili v severni Afriki in na Bližnjem vzhodu že opazovani roji z več tisoč osebki, ki jih višinski vetrovi raznašajo ne le po Sredozemlju in v Srednjo Evropo, temveč tudi dlje na sever. Ob tem se ni mogoče izogniti omembi paradoksalne zanimivosti, da je afriški minljivec edina na Islandiji ugotovljena vrsta kačjega pastirja (Schorr, 1990; Corbet, 1999).

V Sloveniji je bil afriški minljivec doslej opazovan že večkrat: leta 1996 pri Proseniškem v bližini Celja (Pirnat, 1997), leta 1996 pri Harijah v bližini Ilirske Bistrice (Šalamun *et al.*, 1997), leta 1998 pri Račah v bližini Maribora (Bedjanič, 1999), v letih 1998, 1999 in 2000 pri Sestržah v bižini Slovenske Bistrice (Bedjanič, 1999, 2000; Labus, 2000) ter leta 2000 pri Podvincih v bližini Ptuja (Bedjanič, 2000). V deponiji Cinkarne Celje (Proseniško), zbiralniku Mola (Ilirska Bistrica), Račkih ribnikih (Rače) in v zbiralniku Medvedce (Sestrže) so bili julija in septembra najdeni levi ter sveže preobraženi in mladostni osebki, kar dokazuje, da se vrsta pri nas tudi uspešno razmnožuje.

V nadaljevanju predstavljeni podatki v tem oziru pomembno dopolnjujejo sliko o pojavljanju in biologiji afriškega minljivca v Sloveniji.

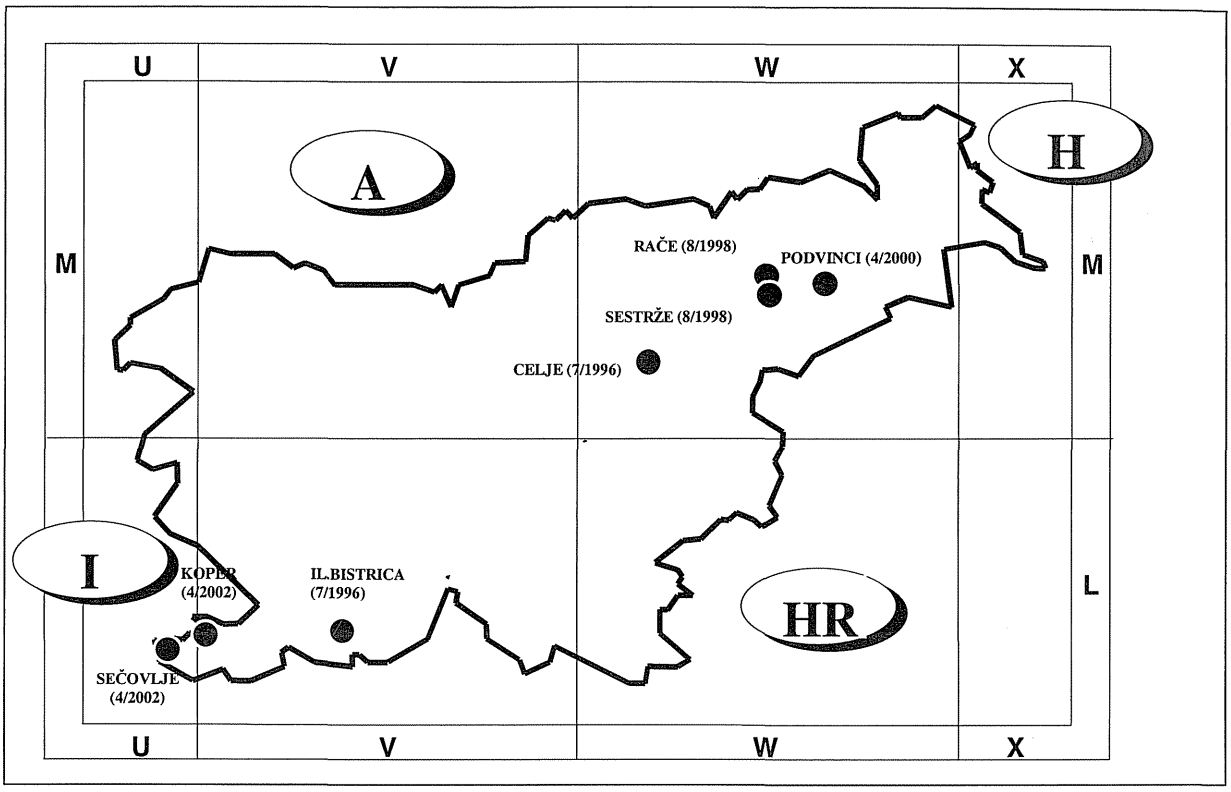
REZULTATI IN RAZPRAVA

Spomladi leta 2000 je bilo na dveh lokalitetah na slovenskem morskem obrežju opazovanih več osebkov afriškega minljivca (Tab. 1).

Afriški minljivci so se na slovenskem morskem obrežju v letu 2000 najverjetneje pojavili sredi meseca aprila, saj je bil takrat nad severno Afriko anticiklon, v srednji Evropi pa globok ciklon z obilnim dežjem in močnim južnim vetrom, ki je nad naše kraje prinesel tudi saharski pesek. Takšna vremenska slika popolnoma ustreza razmeram, v katerih višinski vetrovi zanesejo ptice in žuželke daleč proč od njihovega areala. Zanimivo je, da se opazovanja časovno povsem ujemajo s tistimi iz Štajerske (Bedjanič, 2000), kar daje slutiti močnejšo migracijo iz toplejših južnih krajev, ki pa je drugod po Sloveniji spričo zgodnje sezone najverjetneje ostala spregledana.

Tab. 1: Podatki o opazovanju afriških minljivcev na dveh lokalitetah slovenskega morskega obrežja.
Tab. 1: Data on the observation of Vagrant Emperor Dragonflies at two localities on the Slovene coast.

Datum / *Date*	Število / *No.*	Habitat
SEČOVELJSKE SOLINE / *SEČOVLJE SALINA*		
18. 4. 2000	Več osebkov / *A number of individuals*	Slan travnik nasproti letališča / *Salt meadow opposite the airport*
21. 4. 2000	Samec in samica / *male and female*	Koleselj (samec in samica med parjenjem) ob nasipu osrednjega solinskega jarka / *Copula along the levee of the central salt-pan channel*
28. 4. 2000	1 samec / *1 male*	Na rastišču slanuš ob nasipu jarka Picchetto / *On the site of halophilous plants along the levee of the Picchetto channel*
30. 4. 2000	5 samcev in 1 samica, 1 koleselj / *5 males and 1 female, 1 copula*	Na slanišču ob jarku Picchetto / *In saltmarsh along the Picchetto channel*
2. 5. 2000	1 samec / *1 male*	Ob jarku Picchetto / *Along the Picchetto channel*
ŠKOCJANSKI ZATOK – *ŠKOCJAN INLET*		
20. 4. 2000	3 samci / *3 males*	Trstišče pri luški ograji / *Reed-bed along the Port of Koper's fence*
23. 4. 2000	3 samci / *3 males*	Trstišče pri luški ograji / *Reed-bed along the Port of Koper's fence*
25. 4. 2000	–	Nikjer nobenega osebka te vrste / *No individuals of this species to be seen anywhere*



Sl. 1: Pojavljanje (kraj, mesec in leto) afriškega minljivca *Hemianax ephippiger* ***v Sloveniji.***
Fig. 1: Occurrence (place, months and year) of the Vagrant Emperor Dragonfly *Hemianax ephippiger* ***in Slovenia.***

Protokolirana navzočnost na našem morskem obrežju lepo ilustrira klateško naravo te vrste kačjega pastirja. Na nobeni lokaliteti se afriški minljivci niso zadrževali več kot nekaj dni. V Sečoveljskih solinah opazovana samica se je obešala na pritlehne rastline in se splašena vsakič spreletela najmanj petdeset metrov daleč. Samci pa so se ponavljajoče spreletavali nad vodo (nad ožjimi solinskimi jarki, pa tudi na obrežju jarka Pichetto), vendar to ni nikjer trajalo posebno dolgo časa. Čeprav je bil dvakrat opazovan koleselj (domnevno dveh parov), odlaganje jajčec ni bilo evidentirano. Kljub temu je ostajalo upanje, da bodo kasneje najdeni mladi, sveže preobraženi osebki. Larvalni razvoj afriškega minljivca poteka namreč zelo hitro, preobrazba v odraslo žuželko pa v topli plitvi vodi traja le dva do tri mesece. Kasnejša preverjanja na tem območju žal niso bila uspešna. Sicer pa je afriški minljivec ena tistih prikazni, za katero ljudje vedo povedati, da so padli z neba, ko se nenadoma prikažejo nad neko po daljšem času oživelo lužo. Poleg same klateške narave odraslih osebkov lahko namreč tudi njegova jajčeca prestanejo dolgotrajno sušo in nadaljujejo razvoj po dolgem obdobju neugodnih razmer.

Navalništvo, klateštvo in začasno pojavljanje so tri tesno povezane značilnosti afriškega minljivca, ki je prilagojen tako vročini kot mrazu, tako dežju kot vetru, tako suši kot povodnji, tako sladki kot brakični vodi, torej povsem skrajnostnim življenjskim razmeram na rahlo poraslih goličavah na obrobju plitvih stoječih voda.

Sl. 2: Par afriških minljivcev *Hemianax ephippiger* ***med kopulo dne 30. 4. 2000 v Sečoveljskih solinah (Foto: I. Geister).***
Fig. 2: Pair of Vagrant Emperor Dragonflies *Hemianax ephippiger* ***during copula on April 30th 2000 at Sečovlje Salina (Photo: I. Geister).***

ZAKLJUČEK

Spomladi leta 2000 se je na slovenskem morskem obrežju zadrževala skupina afriških minljivcev *Hemianax ephippiger.* Na travnatih nasipih solinskega jarka in slaniščih na obrobju opuščenih solinskih bazenov v Sečoveljskih solinah je avtor v dneh od 18. 4. do 2. 5. 2000 opazoval največ 7 samcev in 3 samice. V Škocjanskem zatoku so se na nasutih in s trstom poraslih tleh na obrobju poloja v dneh od 20. 4. do 25. 4. 2000 zadrževali 3 samci. V Sečoveljskih solinah je bila 21. 4. in 30. 4. 2000 opazovana tudi kopula. Kljub preverjanju v naslednjih mesecih razvoj afriškega minljivca (najdba ličink, preobrazba) na tem območju ni bil potrjen. Vsi doslej znani podatki o pojavljanju vrste v Sloveniji so združeni in prikazani na karti razširjenosti (Sl. 1).

OCCURRENCE OF THE VAGRANT EMPEROR DRAGONFLY *HEMIANAX EPHIPPIGER* (BURMEISTER, 1839) ON THE SLOVENE COAST (INSECTA: ODONATA)

Iztok GEISTER
Institute of Faunistics Koper, SI-6276 Pobegi, Sv. Anton, Kocjančiči 18

SUMMARY

In spring 2000, a group of Vagrant Emperor Dragonflies Hemianax *ephippiger were seen frequenting the Slovene coast. Between April 18th and May 2nd 2000, the author observed max. 7 males and 3 females on the grassy levees of the salt-pans channel and in saltmarshes on the edge of the abandoned salt basins of the Sečovlje Salina. At Škocjan Inlet (Koper area), 3 males were observed between April 20th and April 25th 2000 on the ground covered with rubble and overgrown with reed, as well as on the edge of a mudflat. At Sečovlje Salina, a copula was also registered between April 21st and April 30th 2000. In spite of continuous checking in the ensuing months, the Vagrant Emperor Dragonfly's development (larva, metamorphosis) was not confirmed in the above mentioned areas. All of the so far known data on the occurrence of this species in Slovenia are shown on the attached distribution chart.*

Key words: *Hemianax ephippiger*, dragonflies, desert sand, periodic visitor, Adriatic coast, Slovenia

LITERATURA

Bedjanič, M. (1999): New records of *Hemianax ephippiger* (Burmeister, 1839) in Slovenia (Anisoptera: Aeshnidae). Exuviae 6: 14-18.

Bedjanič, M. (2000): Drobtinice in ocvirki: afriški minljivec *Hemianax ephippiger*, zgodnji trsničar *Brachytron pratense*. Erjavecia 9: 20-22.

Corbet, P. S., (1999): *Dragonflies: Ecology and Behaviour of Odonata.* Harley Books, Colchester. xxxiii+829 str.

Labus, N. (2000): *Kačji pastirji akumulacije Medvedce z biologijo kritično ogroženih vrst.* Raziskovalna naloga za 17. srečanje mladih raziskovalcev za napredek Maribora, II. gimnazija Maribor, Maribor. 30 str.

Pirnat, A. (1997): *Hemianax ephippiger* (Burmeister, 1839), a new species in the dragonfly fauna of Slovenia (Anisoptera: Aeshnidae). Exuviae, 4/1, 1-3.

Schorr, M. (1990): Grundlagen zu einem Artenhilfsprogramm Libellen der Bundesrepublik Deutschland. Ursus Scientific Publishers, Bilthoven.

Šalamun, A., A. Pirnat, M. Bedjanič & M. Kotarac (1997): Prispevek k poznavanju favne kačjih pastirjev (Odonata) jugozahodne Slovenije. *V:* M. Bedjanič (ured.), Raziskovalni tabor študentov biologije Podgrad '96, str. 55-74, ZOTKS – Gibanje znanost mladini, Ljubljana.

MISCELLANEA

original scientific paper
received: 18. 4. 2002

UDC 612.76-053.5

INFLUENCE OF BIOMECHANICAL PROPERTIES OF PARTICULAR SKELETAL MUSCLES ON CHILD MOTOR DEVELOPEMENT

Rado PIŠOT
Science and research centre of Republic of Slovenia, Koper, SI-6000 Koper, Garibaldijeva 18

Boštjan ŠIMUNIČ & Vojko VALENČIČ
Faculty of electrical engineering, University of Ljubljana, SI-1000 Ljubljana, Tržaška cesta 25

ABSTRACT

Motor activity in childhood is extremely important for general development of a child, yet there is still not enough information about the children's motor development. Already in the structure of the motor space of the child itself, especially in the mechanisms that govern the movement, it is possible to perceive peculiarities that cannot be ignored when choosing the appropriate way of working with the child. The power of argument of kinesiology, however, is based first of all on appropriate, objective and reliable information, since only verified data can be applied in practice as a basis for the development of exercise programs suitable for the child. In this study TMG (tensiomiography), as a non-invasive measuring method for detection of contractile properties of skeletal muscles, has been applied

Key words: tensiomiography, skeletal muscles, electrical stimulation, primary school pupils, atlas of skeletal muscles

INFLUENZA DELLE PROPRIETÀ BIOMECCANICHE DI DETERMINATI MUSCOLI SCHELETRICI SULLO SVILUPPO MOTORIO DEL BAMBINO

SINTESI

Benché durante l'infanzia l'attività motoria sia estremamente importante per lo sviluppo generale dei bambini, non siamo ancora in possesso di informazioni sufficienti riguardo al loro svilluppo motorio. È già nella struttura dello spazio motorio dei bambini, specialmente nei meccanismi che ne governano il movimento, che possiamo percepire peculiarità che non possono venir ignorate durante la scelta del metodo di lavoro più appropriato con i bambini. Comunque, la potenza dell'argomento della cinesiologia è basata prima di tutto su un'informazione appropriata, obiettiva ed attendibile, visto che solamente dati verificati possono venir applicati in pratica, come base per lo sviluppo di programmi d'esercizio adatti ai bambini. In questo studio la TMG (tensiomiografia) è stata applicata come metodo di misura non invasivo per la scoperta delle proprietà contrattili dei muscoli scheletrici.

Parole chiave: tensiomiografia, muscoli scheletrici, stimolazione elettrica, allievi della scuola elementare, atlante dei muscoli scheletrici

INTRODUCTION

The development of a child involves qualitative and quantitative changes that are permanent and are represented by the change in the structure of the psychosomatic status. The quantitative changes are reflected mainly through anatomic and functional changes that occur during the physical growth. In the first two years the growth is extremely rapid, later it gets a little more moderate, but in the age of adolescence it becomes more turbulent again. The changes occurring in the physical growth can be perceived in the proportions among individual parts of the body as well as in their structure.

The development of a child determines the qualitative changes in the psychosomatic status and as such it is based on the maturing of the nervous system, allowing the child to advance to a higher level of functioning. The process of maturation is hereditary, therefore we are not able to interfere with the sequence of abilities and readiness for action. However, providing a child with an experience-rich environment will help him develop certain forms of activities faster and with a stronger intensity.

In the early childhood mainly the rough motor abilities are developed, the fine motor abilities following gradually from the age three on. In the early stages of the motor development the muscular structure is composed mostly by slow muscular fiber, involved in slow – major motor units that allow a child to perform rough and inaccurate movement. A finer correction of the movement is performed by means of minor – rapid motor units. In the further stages of the child's development the muscular fiber become classified into slow, rapid – persistent and fast – wearing. The fastest development of this classification takes place until the age three and continues until the end of the puberty. This development progresses in correlation with the effectiveness of the functioning of individual centres in the central nervous system and the mechanisms that control and coordinate the functioning of the peripheral system. The control of the peripheral system in turn is an outcome of the processes of learning, which coincide with the child's susceptibility and stage of the development of the whole organism. As the child's development as a whole does not always proceed continuously, the processes of acceleration and retardation must be taken into consideration as well when examining it. In addition to lack of movement stimuli, irregular growth, inadequate development of the nervous system, various emotional and social factors or belated intellectual development are the main causes for retarded and unbalanced motor development.

On the basis of physiological, psychological and neurological findings Luria (1976) developed the theory of functional organization of the brain and its systems. He divided the brain in three basic blocks: the block for the regulation of tonus and the state of alertness, the block for the reception, processing and storing information and the block for programming, regulating and control of complex operations. Each human activity demands coordinated functioning of all the three blocks. In each of the three brain blocks there is a hierarchic structure of three zones – from the simplest to the most complicated one. They are: the primary (projection) zone, the secondary (projection-associative) zone and the tertiary (associative) zone. The tertiary zone plays the most important role in the creation of the most demanding forms of activities and makes possible the coordinated work of the cortical analysers, so its function is to integrate the cortex of the cerebrum. These most developed areas of the cortex are the last to mature. The mielinisation ("maturation" of the nervous paths) of the primary zones is accomplished relatively early, while the mielinisation of the secondary and more so of the tertiary zones takes longer – it is accomplished as late as approximately at the age of seven or even later.

Too little motor activity or complete absence of it in education of growing up youth cannot be entirely compensated later on, as with the progress of growth and maturing the influence of motor stimuli weakens. The lack of experience and opportunities to practice motor activities can make the motor as well as the intellectual development of a child slower (Kelly & Kelly, 1985; Humphrey, 1991). In early childhood the child is very susceptible for the impulses from the environment. The influence of motor activities on his development as a whole is most important at this age (until the age five), after that it gradually decreases. For a young child motor activity is of crucial importance as it includes all areas of expression: motor, cognitive, conative, emotional and social. All these areas have (as a means of reinforcement) a very important role in the learning process itself (Gardner, 1995; Kiphard, 1989; Pišot, 2000a, 2000b) as well as in the formation of the child's personality as a whole.

The relation between the motor and cognitive capabilities and their influence in the regulation of movement must be explained through the phenomenon of the development of a child as a whole. In his "multiple intelligence theory" Gardner (1995) discusses the dimensions of human mind and defines (among others) the body- movement intelligence. He explains it as the capability of using one's own body in various skilful ways and a capability of skilfully manipulating objects. Also F. Bartlet (according to Gardner, 1995) emphasis the importance of these connections in motor activities. He claims that the same principle that has been discovered in clearly physical demonstration of motor skills is true also of the majority of processes to which we usually refer to as processes of thinking. The theory on this relation, that is particularly strongly present in a child, is

being reinforced also by the latest findings of neuropsychologists. In his research on how brain hemispheres are activated during motor activities R. Sperry (Gardner, 1995) pointed out that mental activities must be considered as a means that allows us to carry out action. The processes in the brain should therefore be considered as a means of bringing into motor behavior a higher degree of detail, a more intense focusing towards the objective and a higher degree of general adaptability. The development of motor abilities of a child should thus be considered in a broader sense, not only with regard to physical activities in childhood, but taking into account all sorts of cognitive operations (Bruner and Fischer, quoted in Gardner, 1995). Coordinated action of mechanisms for reception, processing and analysis of afferent and reafferent information in the central nervous system, the activity of the inner and of the outer regulation circuit and of the highest cortical structures in both hemispheres is necessary for effective performing of motor structures.

The role of cognitive activity in the regulation of movement has been explicitly pointed out in various research that set to define the phenomenon and functional model of the motor space structure (Mejovšek, 1979; Madič, 1986; Planinšec, 1995; Pišot, 1999). The cognitive activity is crucial to optimal performance of motor tasks and it is particularly important in the performance of apparently simple tasks. These interrelations occur most frequently when a child grows up, due to their developmental peculiarities.

The early childhood is a particular phenomenon in the explanation of the regulation of movement. The research data leads to the formation of a hypothetical model of the structure of a child's motor space, being a great deal different from the adult's motor space (Pišot, 1999). The latter is classified into three dimensions that represent a child's motor space and as motor abilities guarantee his motor efficacy:

- Coordination – different forms of coordination that refer to motor tasks that are a part of informational and energetic component of movement.
- Strength – different forms of strength that represent the energetic support in the performance of certain relatively simple motor tasks.
- Balance – represents a kind of a filter in the regulation of movement, the presence or absence of which enables and stimulates or prevents and hinders the performance of complex as well as apparently simple motor tasks.

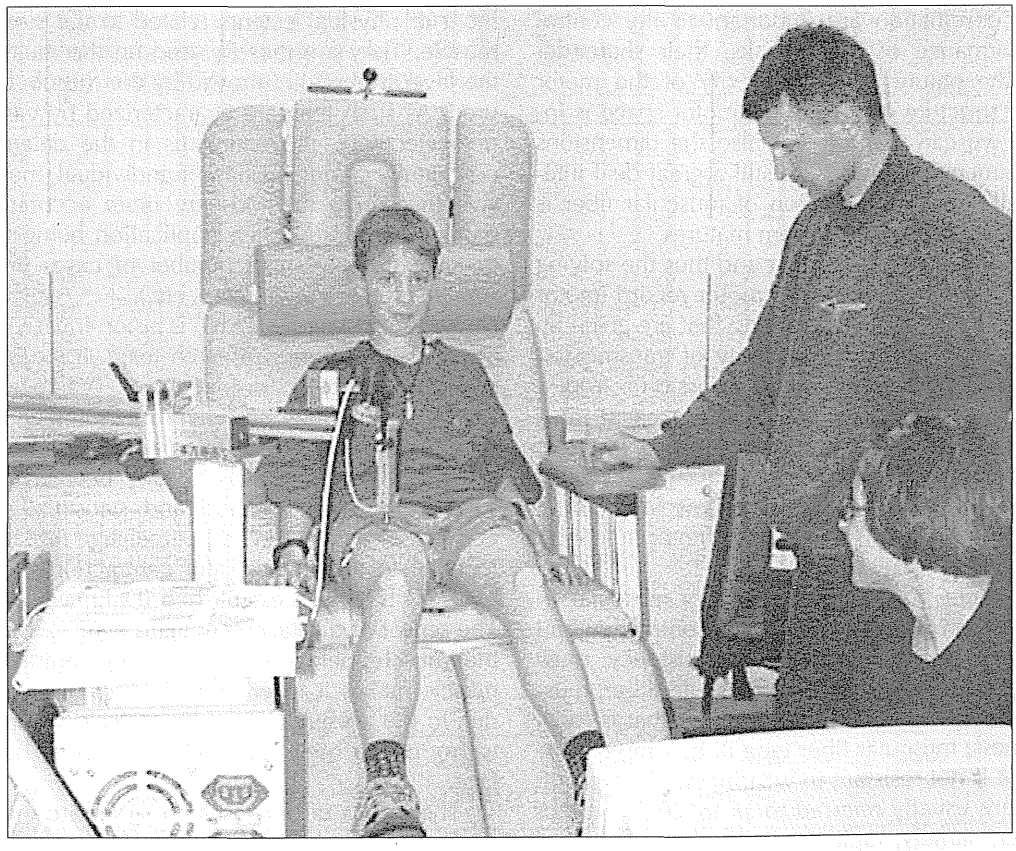


Fig. 1: Child's measurements: tensiomiographic measurements in the lab.
Sl. 1: Slika meritev otrok: primer meritve tenziomiografije (TMG) v laboratoriju.

Besides the fact that a large portion of the structure of the child's motor space is related to different forms of coordination (the role of the informational component of movement) and the fact that balance (adaptation) functions as a filter in the child's performance of movement, energetically supported by a basic level of strength, the realization of motor tasks is significantly subjected also to child's cognitive activity. Interrelations and contributions of the above mentioned dimensions enable a child to perform motor tasks and to solve motor problems until other motor abilities (coordination, strength, balance, speed, flexibility, precision) are differentiated in the child's development. These are the motor abilities that represent the basis in the realization of adult's motor efficacy along with functional predisposition (persistence). The development and consequently the differentiation of the central nervous system are crucial to this process.

Discussing the dimension of coordination in further detail we should point out its double form of occurrence: the inter-muscular and the intra-muscular forms. The former is particularly important in the realization and activation of various kinetic chains involved in the solving motor problems. The intra-muscular form is defined by the differentiation and the quantity of activation of different muscular fiber inside individual muscles involved in the solving motor problems. Both forms of occurrence of coordination are important to the control and the performance of motor tasks, their share depending on the nature and complexity of the motor problem. The structure of the child's motor space is integrative and we can assume that also the dimensions on the intra-dimensional level are still a great deal integrative as well. The differentiation of muscular fiber is completed when the nervous system matures.

The performance of a motor act and thus the solving of the motor problem involves the motor record (motor knowledge – programs), predisposition that are given by the level of motor abilities, the quality of transmission paths (neural and neuromuscular transmission – from a receptor to an executor) and executors – skeletal muscles as an important part of the motor system. Humans move in many different and complex ways on the range of fast and simple motor reactions to slow long-lasting movements in sequence. The variety in motor activity is granted by proper musculature.

Skeletal muscles form various types of muscular fiber, classified according to the speed of contraction and according to the level of contracting persistency: muscular fibre type I. – slow, persistent muscular fiber; muscular fiber type II. a. – rapid muscular fiber that is resistant to weariness; muscular fiber type II. b. – rapid muscular fiber that is not resistant to weariness. The types II. a. and II. b. are usually referred to as to single type of muscular fiber, namely, rapid muscular fiber. Slow and persistent (tonic) muscles are therefore mainly composed by slow muscular fiber (soleus, tibialis, *etc.),* while rapid (fasic) muscles are mainly composed by rapid muscular fiber (triceps brachii, vastus lateralis, *etc.).* Specific exercise influences mainly the development of rapid muscular fiber and thus rapid muscles. The contracting characteristics of skeletal muscles can be influenced either consciously (the influence of the training process and of the nature of motor activity), or unconsciously (neuro-muscular illness, injuries, *etc.).*

The quantity and the quality of motor activity offered a child in different social environments influences the differentiation of characteristics of muscular fiber, as well as a congruent and logical development of skeletal muscles. The latter is extremely important for a balanced motor development of a child, a development of a healthy poise and locomotor sistem in general. At the same time it is crucial to successful integration and direction of children and youngsters in various sports disciplines.

METHODS

Measurement of skeletal muscles is a wide area of research on physiology and muscle functioning, interesting to doctors in diagnostics, rehabilitation and surgical operation, sports doctors as well as scientists. The measuring methods are based mostly on the measurement of physical extents related to the strength of the muscle. They are thus focused on the measurement of the lever in the joint moved by the muscle being measured. As such they are characterized by variability and non-selectivity, preventing us in the determination of contacting characteristics of individual muscles. Invasive measuring methods are more accurate, but they damage the tissue, their application being thus limited to an extremely small number of cases (muscular illnesses, research on corpses, etc.).

Tensiomiography (TMG) is a non-invasive measuring method used by our research team. It measures the radial muscle belly displacement (Valenčič & Knez, 1997). It provides selective measurements of radial muscle belly displacement as a response to single electrical stimulus. TMG has already been evaluated with torque measuring method and statistically significant correlation between type I percentage (obtained by histochemical techniques) and contraction time obtained by TMG has been established (Dahmane *et al.*, 2001). The sensor of displacement leans against the skin above the muscle being measured. The contraction of the muscle makes it fatter in a certain spot (muscle belly), due to the preservation of the muscle volume. The fattening of the belly muscle is tangible on the skin surface.

The results of our research so far are the measuring device, optimisation of the sensor positioning parameters and comparison of the TMG measuring method with the measurement of the lever in the corresponding joint,

histo-chemical analyses and electro-myographic shots. The reaction of the conscious and unconscious muscle contractions were being observed.

The preliminary research will be dedicated to the analysis of reaction of several muscles in 240 healthy children (125 boys and 115 girls), gathering elementary data and formulating a broader future research project. The measured children were 9.1 years old, standard deviation 0.4 years, they were healthy at the time of the measuring and in the immediate period before. We were interested in the differentiation of measured muscles into slow and rapid, the sample of muscles having been carefully selected (the most important muscles in the every-day motor activities in the sports class: sprinting, jumping, etc.). After having collected the signed agreement from the children's parents we started measuring the tensiomiography on selected muscles:

- m. biceps brachii (BB)
- m. vastus lateralis (VL)
- m. biceps femoris (BF)
- m. erector spinae (ES)

RESULTS AND DISCUSSION

In the twitch TMG response curve the following parameters have been defined: maximal displacement (Dm) and contraction time (Tc), see Figure 2. Maximal displacement assesses the maximal amplitude of muscle belly response and is strongly related to muscle force. Contraction time defined from 10% to 90% of maximal displacement achieved assesses the speed of muscle contraction.

The analysis of the data collected with tensiomiography, namely the time of contraction of the four selected muscles showed that vastus lateralis and erector spinae are rapid muscles, they are key muscles in the extension of the knee and lower back, respectively (Fig. 3). The biceps femoris, the muscle involved in the flexion of the knee, is the most important muscle in the achievement of the maximum running speed and was found to be a slow type of muscle. The biceps brachii is extensor of the elbow and was compared to lower limb muscles where we found out that was statisticaly faster than vastus lateralis and slower than biceps femoris.

The specifics of a child's movements are more likely walking and running than fast sprinting, therefore we expected differences in the contraction time of front and back muscles of femur. The hypothesis was that BF muscle was slower than VL muscle, which is used frequently in the child's every-day motor activity. The slower muscles are activated only during the maximum physical effort or in particular, unusual positions of the body. The data gathered show the choice of muscles to be crucial, especially the muscles involved in a wide range of motor activity, so that we can be able to give useful advice to children as to which sport discipline to join.

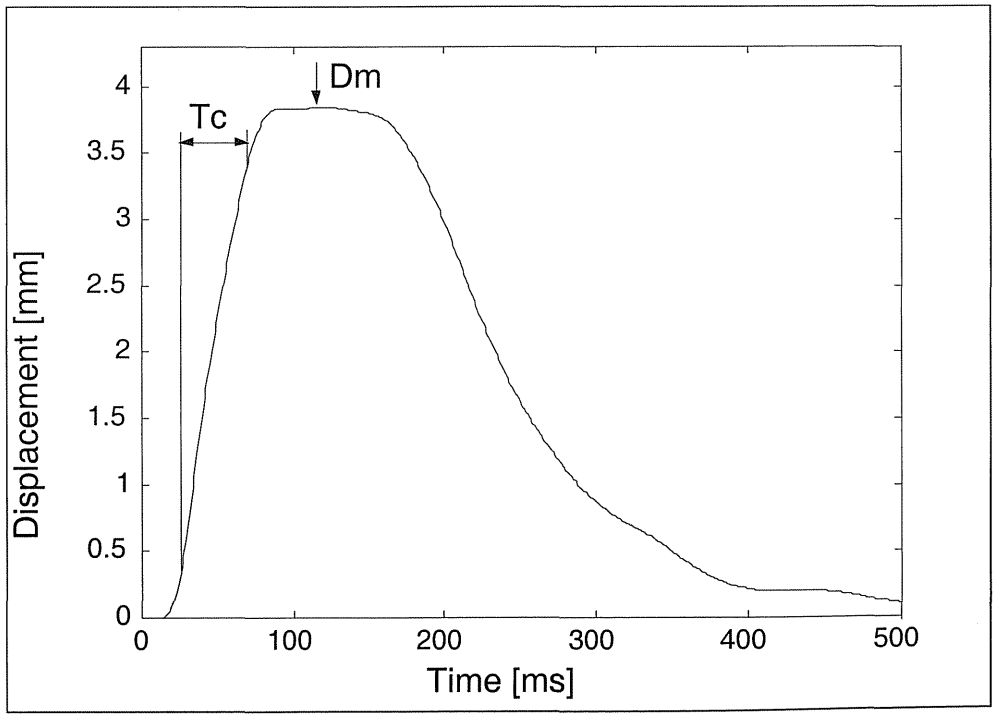


Fig. 2: TMG response and definition of TMG parameters.
Sl. 2: Odziv tenziomiografije (TMG) in definicija parametrov.

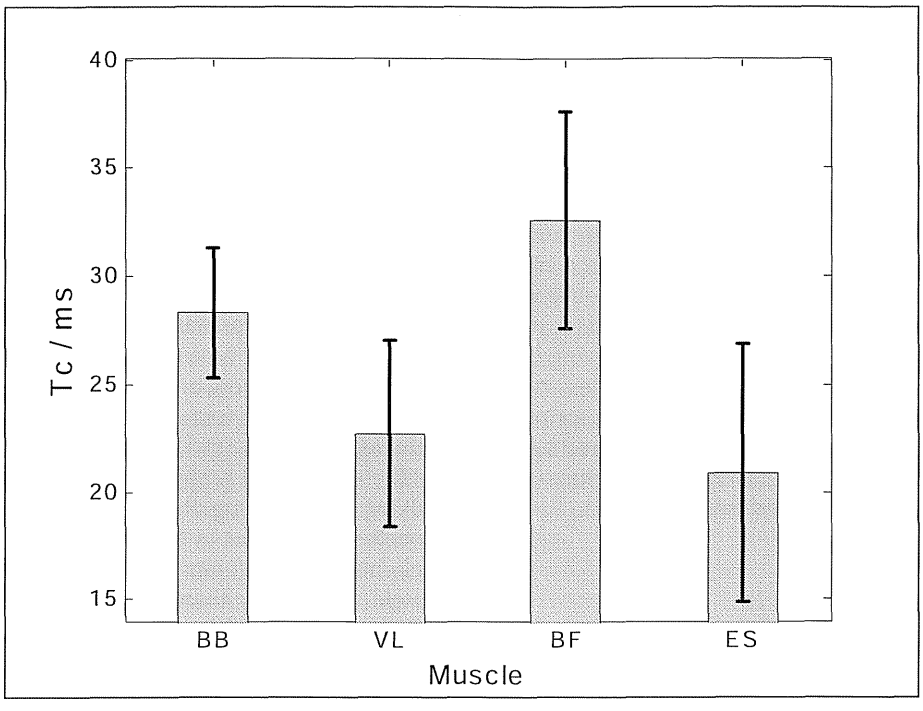


Fig. 3: Differences in contraction time (Tc) for the four different muscles measured on 240 subjects. Legend: BB – musculus biceps brachii, VL – m. vastus lateralis, BF – m. biceps femoris, ES - m. erector spinae.
Sl. 3: Razlika v času kontrakcije (Tc) za štiri različne mišice, izmerjene na 240 osebkih.

CONCLUSIONS

The data gathered show the level of passing from every-day motor activity over to the field of sport participation. Such data will allow us to advise children as to which sport discipline to join.

As it has already been stated, the preliminary research that has been carried out gave us an elementary database and will serve as a basis for larger research project to determine the role of the biomechanical characteristics of the skeletal muscles in the motor development of children. We will draw further conclusions on the basis of referential data gathered on a larger representative pattern of 900 children attending elementary schools in Slovenia. The results of the research will be analysed and they will be taken into consideration in the formulation of an atlas containing data about biomechanical characteristics of the children's measured skeletal muscles. Other data, such as children's sex and sports folder results will also be taken into account. The data in the atlas will serve as a basis for comparisons of measured individuals and average results in healthy children.

The reaction time of skeletal muscles is determined by the genetics, the physical practise can change the composition of the muscle only partially. It is every adult's wish to raise a healthy, normally developed and properly educated child. Strictly medically and statistically he should be within the normal range of value according to his age and sex. Our research is set to determine the normal ranges and values regarding the biomechanical characteristics of skeletal muscles, to discover whether the motor development is symmetrical from the point of view of the biomechanical characteristics of skeletal muscles, what are the deviations and probabilities. Early measurements of skeletal muscles could become a means of discovering eventual deviations in the physical and motor development of a child in the early stages, later it could help directing children in appropriate motor activities and sport disciplines in which they could achieve the best results. The composition of the biomechanical atlas of skeletal muscles of elementary school children would also acknowledge the important role of the measuring method, a result of a many years' research of national (Slovene) scientists.

VPLIV BIOMEHANSKIH LASTNOSTI NEKATERIH SKELETNIH MIŠIC NA GIBALNI RAZVOJ OTROKA

Rado PIŠOT
Znanstveno raziskovalno središče Republike Slovenije, Koper, SI-6000 Koper, Garibaldijeva 18

Boštjan ŠIMUNIČ & Vojko VALENČIČ
Univerza v Ljubljani, Fakulteta za elektrotehniko, SI-1000 Ljubljana, Tržaška cesta 25

POVZETEK

Količina in kvaliteta gibalne aktivnosti v katero otroka sili različno socialno okolje, vpliva tako na diferenciacijo lastnosti mišičnih vlaken, kot na skladen in smiseln razvoj skeletnih mišic. Ta je izredno pomemben za ravnovesje v otrokovem gibalnem razvoju, razvoj zdrave drže in lokomotornega aparata nasploh, ob tem pa tudi odločujoče vpliva na uspešno vključevanje in usmerjanje otroka, in mladostnika v posamezne športne zvrsti. Tako kot velja za celotno strukturo motoričnega prostora otroka lahko sklepamo, da je tudi znotraj posamezne dimenzije integrativnost še zelo velika. Popolna diferenciacija mišičnih vlaken se zaključi z razvojem živčnih centrov in poti. Za realizacijo gibalnega akta oz. rešitev gibalnega problema pa so, ob suportu, ki ga zagotavlja gibalni/motorični spomin (gibalna znanja – programi) in predispozicijah, ki jih nudi raven gibalnih/motoričnih sposobnosti ter kvaliteta prenosnih poti, zadolženi efektorji – skeletne mišice kot pomemben del gibalnega sistema. Človekovo gibanje je izredno raznovrstno in kompleksno od hitrih enostavnih motoričnih reakcij do dolgotrajnih počasnih zaporednih gibanj. Primerna muskulatura mu omogoča to raznoliko aktivnost.

Merilna metoda tenziomiografija (TMG), ki jo uporablja raziskovalna skupina, je neinvazivna merilna metoda, ki temelji na merjenju radialnega premika trebuha mišice. Senzor premika je prislonjen na kožo nad merjeno mišico z začetnim pritiskom. Ko se mišica skrči, se zaradi ohranitve volumna mišice na določenem mestu odebeli (trebuh mišice). Odebelitev trebuha mišice lahko zaznamo na površini kože. Večina uporabljanih merilnih metod temelji na merjenju fizikalnih veličin, ki so povezane s silo mišice. Takšna metoda je merjenje navora v sklepu, ki ga merjena mišica premika. Slabost takšnih metod je poleg variabilnosti tudi neselektivnost metode, zato ne moremo določiti kontraktilnih lastnosti ene same mišice. Bolj natančne so invazivne metode merjenja, ki poškodujejo tkivo in njihova uporaba je omejena na zelo ozek krog primerov (mišična obolenja, študije na kadavrih, itd.).

V raziskavi, ki bo med drugim služila za nabor informacij in zasnovo širšega raziskovalnega projekta na vzorcu otrok, smo analizirali odzive več mišic pri 240 zdravih otrocih (125 dečkov in 115 deklic). Merjenci so bili stari 9,1 leta, standardna deviacija 0,4 leta, vsi zdravi in brez prebolelih bolezni v kratkem obdobjem pred meritvijo. Zanimala nas je diferenciacija merjenih mišic na počasne in hitre pri otrocih te starosti, pri tem smo vzorec mišic izbrali skrbno in upoštevali najpomembnejše mišice za vsakodnevno gibalno aktivnost otrok pri pouku športne vzgoje (šprint, skoki). Po pisni privolitvi, ki smo jo pridobili s strani njihovih staršev smo izvedli meritve tenziomiografije na izbranih mišicah. Dobljeni podatki kažejo, da je potrebno skrbno izbrati vzorec mišic, predvsem tistih mišic, ki so značilne predstavnice kar najširšega spektra gibanja, da lahko otrokom kar najbolj svetujemo pri vključevanju v različne športe.

Ključne besede: tenziomiografija, skeletne mišice, električna stimulacija, osnovnošolci, atlas skeletnih mišic

REFERENCES

Dahmane, R., V. Valenčič, N. Knez & I. Eržen (2001): Evaluation of The Ability to Make Non - Invasive Estimation of Muscle Contractile Properties on The Basis of The Muscle Belly Response, Medical and Biological Engineering and Computing, Vol. 39.

Gardner, H. (1995): The frames of mind. Tangram, Ljubljana.

Humphrey, J. H. (1991): An Overview of Chidhood Fitness. Charles C. Thomas Publisher, Springfield, Ilinois.

Kelly, N. T. & B. J. Kelly (1985): Physical Education for Pre - School and Primary Grades. Charles C. Thomas Publisher, Springfield, Ilinois.

Kiphard, E. J. (1989): Psychomotorik in Praxis und Theorije. Flottmann Verlag, Guterslah.

Luria, A. R. (1976): Osnovi neuropsihologije (Basis of neuro psychology). Nolit, Beograd.

Madič, B. (1986): Odnos biomotoričkih dimenzija i kognitivnih sposobnosti dece predškolskog uzrasta. Filozofski fakultet u Nišu, Zbornik radova 10, 263-268, Niš.

Mejovšek, M. (1979): Relacije kognitivnih i motoričkih sposobnosti. Kineziologija, štev. 1-2, 83-90, Zagreb.

Pišot, R. (1999): Latent structure of six-and-a-half years old boys motor space after partialization of morphological characterists. 4th Anual Congress of the European College of Sport Science -"Sport Science '99 in Europe". Proceedings book, Rome University, Institute of Motor Science, Rome, Italy, str. 781-783.

Pišot, R. (2000a): Latentna struktura motoričnega prostora šestinpolletnih dečkov. Ann, Ser. hist. nat., 1999, let. 9, št. 1/15, str. 119-132.

Pišot, R. (2000b): The analysis of the structure of six-and-a-half years old children s motor space in the light of its development as a whole. Kinanthropologica, 2000, letn. 36, št. 1, str. 67-78.

Planinšec, J. (1995): Relacije med nekaterimi motoričnimi in kongitivnimi sposobnostmi petletnih otrok. Magistrsko delo. Fakulteta za šport, Ljubljana.

Valenčič, V. & N. Knez (1997): Measuring of Skeletal Muscles' Dynamic Properties, Artificial Organs, Vol. 21(3), 240-242.

DELO NAŠIH ZAVODOV IN DRUŠTEV

ATTIVITÀ DEI NOSTRI ISTITUTI E DELLE NOSTRE SOCIETÀ

ACTIVITIES BY OUR INSTITUTIONS AND ASSOCIATIONS

POLEMIKE IN OCENE

POLEMICHE E RECENSIONI

POLEMICS AND REVIEWS

IN MEMORIAM

DELO NAŠIH ZAVODOV IN DRUŠTEV/ ATTIVITÀ DEI NOSTRI ISTITUTI E DELLE NOSTRE SOCIETÀ/ ACTIVITIES BY OUR INSTITUTIONS AND ASSOCIATIONS

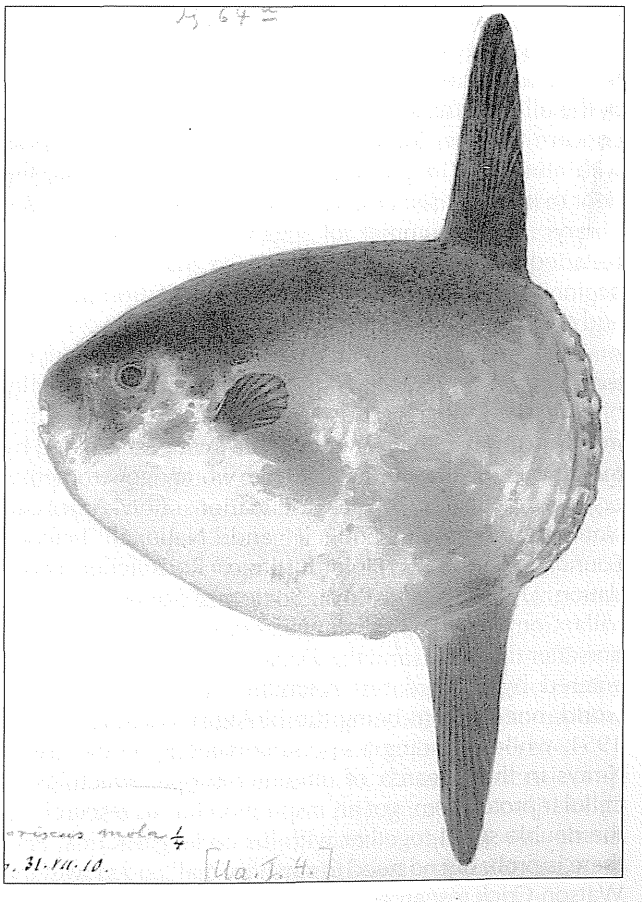
STAZIONE ZOOLOGICA ANTON DOHRN NAPLES
From its establishment till this day

Stazione Zoologica Anton Dohrn

Stazione Zoologica A. Dohrn from Naples, which carries the name of its founder, is a unique research institution in the world, and although some similar institutions in Germany, France and the States had existed prior to its setting up, it has been something special from its very start. The first marine laboratory was founded by P.M. van Beneden, a zoologist and parasitologist, in 1843 in Ostende, followed by those on the Atlantic, Mediterranean and American coasts. These, however, were more or less field stations functioning under the auspices of various universities and institutes, and were primarily intended for the students eager to study marine biology within the framework of some short-term field exercises. *Stazione Zoologica* belongs, however, to the second group of marine laboratories, founded as independent research and advanced study centres. At that time, such laboratories were also in Trieste and Sevastopol.

Stazione Zoologica was the fulfilment of all Dohrn's dreams and wishes; on his own account, with immense will, diligence as well as imagination he constructed, in no more than three years from the time the foundation was laid in 1872 in the Villa Comunale park in Naples, the building which still stands today. Although it was officially opened on April 14th 1875, the first scientists from Germany, Great Britain, Russia, Italy and Holland had worked there as guests as early as in 1873, while the city aquarium began to function a year later. During the first few centuries, from its establishment to the beginning of World War I, the station held the status of a private German foundation. It did not have its own research orientation but, on the contrary, was offering space, infrastructure (equipped labs, and vessels later on) and immense diversity of flora and fauna of the Gulf of Naples. It was the visiting scientists, including the world-famous Norwegian zoologists and Nobel Prize winner Fridtjof Nansen, who laid the foundations of the permanent research activities and orientations towards various branches of marine biology; here they marked out the basics of embryology, comparative anatomy, systematic zoology and botany, physiology and bacteriology. The most important department in the first years of its development, however, was undisputedly zoology with emphasis on morphology. Apart from the increased widening of the areas of research, the foreign scientists were being joined by domestic Italian scientists and technicians, the best known among them being Salvatore Lo Bianco, a taxidermist from Naples, whom Anton Dohrn took under his own wing. Some of Lo Bianco's preparations from the end of the 19th century and early 20th century can still be admired in the aquarium and in the Institute's special collection.

During the first and second World Wars as well as in the period between them, *Stazione Zoologica* went through a number of changes: from the initially private institution it was transformed into a semi private institution (*ente morale*), presided by the Executive Committee headed by the Mayor of Naples, and then retained this status until 1982. The Dohrn family, how-



Orthagoniscus mola. ***Drawing by V. Serino (1910), from the special collection of scientific drawings,*** *Stazione Zoologica A. Dohrn,* ***Naples.***

ever, kept its leading role in the institute's direction and scientific policy making until 1967, when the presidency of the Zoological Station's Scientific Board was concluded by Peter Dohrn, the last of the Dohrn family. During the two wars, too, *Stazione Zoologica* retained its special international position, although the so-called "Italian international" character was being increasingly affirmed: the visiting foreign scientists were still highly independent in their research work aided by the station's laboratories and research equipment. More and more independent and unique was also at that time the only scientific project of the institute, which was to complete the systematics of flora and fauna of the Gulf of Naples initialled in the previous century. During World War II, the station was practically closed; there were just a handful of scientists and technicians who were taking care of just some urgent repairs, such as the functioning of the aquarium, and preventing the American soldiers to occupy and destroy the institute. Thus they managed to save, almost in full, its exceptionally rich library by transferring it to a small village in the town's hinterland. To be fair to the allied troops we must underline, however, that the American and British Governments financially supported the Zoological Station at that time by paying wages to its employees and by covering all the maintenance costs, which no doubt raised the reputation of the allied armies. It was due to this very international concern that the Zoological Station was able to reopen, with almost no major wartime consequences at all, the door to its scientists, director Rinald Dohrn and the entire library in the summer of 1944. Research could be restarted at once where it had been interrupted at the beginning of the war, while in 1947 the Station received and paid its first postgraduate students.

In the years following World War II, particularly in the 1950s and 1960s, *Stazione Zoologica* was virtually blossoming: all research and other (technical and infrastructural) activities were in full swing, supported by most reputable institutions in the world, governmental organisations and private foundations (the American National Research Council and National Science Foundation, Woods Hole Institute, Rockefeller Foundation, UNESCO, The Royal Society of London, etc.). In Villa Comunale, world congresses were held virtually one after the other, and the Zoological Station was being entered by the greatest scientific personalities of the world, one of them being the biologist Watson, who in 1951, while attending a scientific meeting on the use of X-rays in the research of ultramicroscopic structures in cellular protoplasm, got an inspiration for his research on the double spiral together with his colleague Crick. And there is probably no need to say how it all ended with the Watson-Crick research.

In 1967, Dohrn's era finally came to an end, due to which a new statute and new rules were necessary for the Station to obtain a solid and permanent financial base. For almost a century the Italian state recognised the Zoological Station's special status as a private institution within a wide international framework. In the mid-1960s, however, this was no longer possible. *Stazione Zoologica* thus yet again entered the tumultuous period of financial-administrative changes, which eventually ended in 1982, when the Italian Parliament adopted a special law on the Zoological Station, by enthroning it as a public institution *(ente pubblico)* of a special scientific concern. This means that the Station is fully financed by the state and controlled by the Ministry of Science and Technology, but is not part of the Scientific National Council's framework like many other national institutions. And this at the same time means a full developmental and scientific autonomy. Thus the descendants of Anton Dohrn managed to retain this unique status, which has accompanied *Stazione Zoologica* from its establishment onwards. With all the changes in the last 30 years, the number of the foreign visiting scientists has also fallen a great deal; in 1978, there were only 48 (in comparison with 130 in 1960). Due to the Station's new requirements and orientations, the scientific tourism from the first half of the 20th century became increasingly less important and at times even useless. The Italian researchers, who came to the Station in the middle of the tumultuous 1960s, still remember their foreign bosses and accaslonally tense relations between the Station's home personnel and "tourist scientists". In spite of this, however, the corridors of the old building are still swarming with foreign scientists. These are postgraduate students, postdoctoral and visiting scientists gathering invaluable knowledge within the walls of *Stazione Zoologica*, the heritage of more than 130 years of scientific research.

The author of the article while paying a visit to the Italian researchers, with** Stazione Zoologica A. Dohrn **in the background. (Photo: V. Saggiomo)

Patricija Mozetič

POLEMIKE
POLEMICHE
POLEMICS

Aleksander Vukovič

"Priročnik za spoznavanje morske flore Tržaškega zaliva" avtorja Claudia Battelija

V reviji Annales 11(2) iz leta 2001 je izpod peresa Nejca Jogana izšla ocena vsebine priročnika z naslovom *"Priročnik za spoznavanje morske flore Tržaškega zaliva"* avtorja Claudia Battellija. Oba sta pedagoška delavca na Ljubljanski univerzi, oba biologa, s tem da je Nejc Jogan po stroki botanik na Biološkem oddelku, Claudio Battelli pa biolog na Pedagoški fakulteti. Verjetno ni nepomemben tudi podatek, ki ga iz predgovora v priročniku ni moč razbrati – namreč, da je Claudio Battelli delal diplomsko nalogo in magistrsko delo iz algologije s podobno vsebino z mojo pomočjo, tako da lahko rečem, da sem ga uvajal v algologijo, pregledoval in popravljal napisano, svetoval pri nastajanju omenjenih del in tudi priročnika.

Na začetku Jogan pravilno ugotavlja, da je pisanje ocene zanj nekoliko zahtevnejša naloga. Ta ugotovitev ni posledica skromne algološke bibliografije, ampak, po moji presoji, preskromnega poznavanja morskih alg, kar je zagotovo rezultat v prvi vrsti pomanjkljivega programa študija morske biologije na Biološkem oddelku Biotehniške fakultete v Ljubljani, poleg tega pa tudi neizkoriščenosti morskih biologov – raziskovalcev, ki bi lahko svoje znanje prenašali na študente biologije. Upam si celo trditi, da je ravno morska vegetacija najslabše zastopana v programu študija, kar se pozna tudi pri izidu različnih strokovnih del, ki vsebujejo oznako "....flora in vegetacija Slovenije". V vseh manjka morska flora, in nepoznavalci bi lahko celo zaključili, da Slovenija nima morja. Pa ni tako, toda avtorji omenjenih del – prispevkov so se zavedajoč nepoznavanja področja temu delu flore rajši izognili, kot pa da bi streljali kozle.

Splošna in temeljna pripomba na oceno je, da avtor verjetno ni hotel razumeti uvodnega poglavja priročnika, v katerem je izrecno poudarjeno, da priročnik ni vseobsegajoči ključ za določanje morskih alg. Upam si celo trditi, da ga v naslednji izdaji najbrž ne bo izdal niti Battelli, še manj pa Nejc Jogan, in bo tako ostal le pričujoči priročnik z vsemi pomanjkljivostmi, ki so v oceni navedene, pravilno ali pa tudi ne.

Mislim, da je treba še enkrat zapisati temeljne cilje priročnika, kot so predstavljeni na straneh 7 in 8:

- Spodbujati uporabnike, ljubitelje ... pri spoznavanju morskih alg in semenk;

- Posredovati ... temeljne značilnosti in posebnosti ... alg in semenk;

- Ponujati ... dijakom ... učiteljem in ljubiteljem morja ... temeljne informacije ... za uvajanje v preučevanje morskih alg in semenk;

- Doseči, da se s pomočjo preprostega slikovnega morfološkega ključa tudi nestrokovnjaki uvajajo v spoznavanje in prepoznavanje morskih alg in semenk.

Ob nastajanju dela z omenjenimi cilji sem sodeloval predvsem zato, ker sem pri delu z učitelji biologije na seminarjih občutil pomanjkanje algološke literature, dostopne in sprejemljive za njihove potrebe in njihovo strokovnost. Ob vseh mogočih obveznostih sam nisem mogel ali pa nisem bil pripravljen narediti nekaj podobnega in sem verjetno zaradi tega pomagal kolegu Battelliju z nasveti, pripombami in literaturo v upanju, da nastaja koristno delo, ne pa zato, da bi ga nekdo moral hvaliti.

Nekatere pripombe si ne bi zaslužile niti omembe, ker pa jih je napisal kolega Jogan, ki bi moral poznati sestavo člankov, knjig, priročnikov in podobne literature, se vendarle zdijo malo nedomišljene. To velja v prvi vrsti za pripombo o literaturi, za katero misli, da je potrebno sklicevanje, kot da priročnik vsebuje poglavje "diskusija".

Druga nedomišljena pripomba zadeva morske trave, za katere pravi, da so mu ljuba skupina. Rastišče morskih trav je dostopno brez posebnih pripomočkov in ni treba zbirati naplavljenih listov (tudi pri kopenskih rastlinah ne nabiramo odpadlih listov). Tudi podatek o cvetenju trav je napačen, saj *Zostera marina* redno in zelo opazno cveti, *Cymodocea nodosa* pa manj opazno, vendar redno. Podobne in še nekatere napake je možno prebrati tudi v članku o morskih travah (Jogan, N., 1994: *Morske trave slovenskega dela Jadrana.* Annales 4) v reviji Annales. Glede rupije pa samo to, da ne raste niti v morju niti v sladki vodi in je stvar vsakega posameznika, kam jo bo uvrstil, za obstoj vrste in njeno prepoznavanje pa ni bistveno. V tem delu je kolega Jogan nedosleden, ko meni, da so alge pomanjkljivo podane, pri cvetnicah pa se zadovolji že z opisom lista in se mu drugi znaki sploh ne zdijo pomembni.

Nekatere posamezne pripombe v oceni sodijo v sklop *corrigenda,* ki priročniku žal manjka, in seveda k pristopu avtorja, ki ima izkušnje z dopolnilnim poučevanjem učiteljev biologije in poučevanjem otrok na nižji stopnji. To mu je bilo tudi vodilo, kako zasnovati priročnik, da bo zadostil zastavljenim ciljem. Zagotovo pa priročnik ni namenjen ljudem, ki se poklicno ukvarjajo s taksonomijo - strokovnjakom taksonomom. Teh je zaradi kakršnihkoli vzrokov že tako ali tako vedno manj, tako da bo verjetno nastal problem, kako uspešno izpeljati aktualne raziskave s področja biodiverzitete.

Na koncu morda samo še to, da takšno ocenjevanje in takšne ocene vendarle ne pripomorejo k boljši kvaliteti, za katero se, mislim, zavzemamo mi vsi, ampak kvečjemu k odvračanju kakršnih koli navdušencev, ki so pripravljeni narediti nekaj koristnega na področju izobraževanja, če tega že ne naredijo botaniki, ki jim je taka naloga nekako pisana na delovno mesto.

OCENE
RECENSIONI
REVIEWS

Joan Barrull and Isabel Mate: TIBURONES DEL MEDITERRÁNEO, Libreria El Set-ciències, Arenys de Mar, 2002, 292 pp.

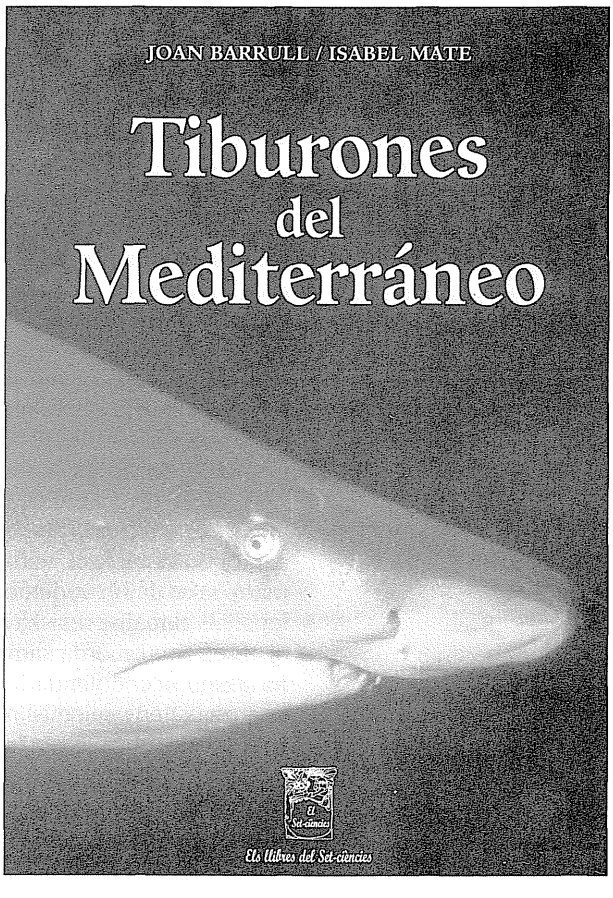
"Tiburones del Mediterráneo", published in 2002 by Libreria El Set-ciències, is one of the most comprehensive books on sharks of the Mediterranean Sea. The authors, Joan Barrull and Isabel Mate, both researchers at the Museum of Zoology in Barcelona, and active members of the Mediterranean Shark Research Group, are widely recognized as shark authorities in this geographic area. They have been researching the shark species featured in the book for many years, writing several scientific reports and articles in magazines on different aspects of sharks' biology and ecology.

The 292 pages of the book include parts about anatomy, reproduction, feeding, fishery and trade, attacks on humans, a key to identification and full description of the 45 species found in the area. There is also a very interesting wide section dedicated to morphometric measurements with a great amount of data collected in part by the authors and in part taken from other sources. The book ends with a glossary and an extensive bibliography.

The authors skilfully combine bibliographical references, data collected by themselves and good pictures. The book includes 125 photographs, mostly shot in Spanish waters (many in colours, a rarity for a book on sharks of this area), as well as 115 fine and precise drawings made by one of the authors, Isabel Mate, who is also a talented wildlife illustrator. All general graphics of the book, which came out in a practical 17x24 cm format, are well designed and the paper is of good quality.

The book has made the main results of the shark research conducted in the Mediterranean Sea available to a wide readership. It will satisfy both the general reader and the scientist working on this matter. This excellent work has rightly taken a place among the main guides written on the subject of the Mediterranean sharks, together with *"Guía de los tiburones de aguas ibéricas, Atlántico Nororiental y Mediterráneo"* by J. A. Moreno and *"Requins de Mediterranée et d'Atlantique"* by J. Cadenat and J. Blache.

Alessandro De Maddalena



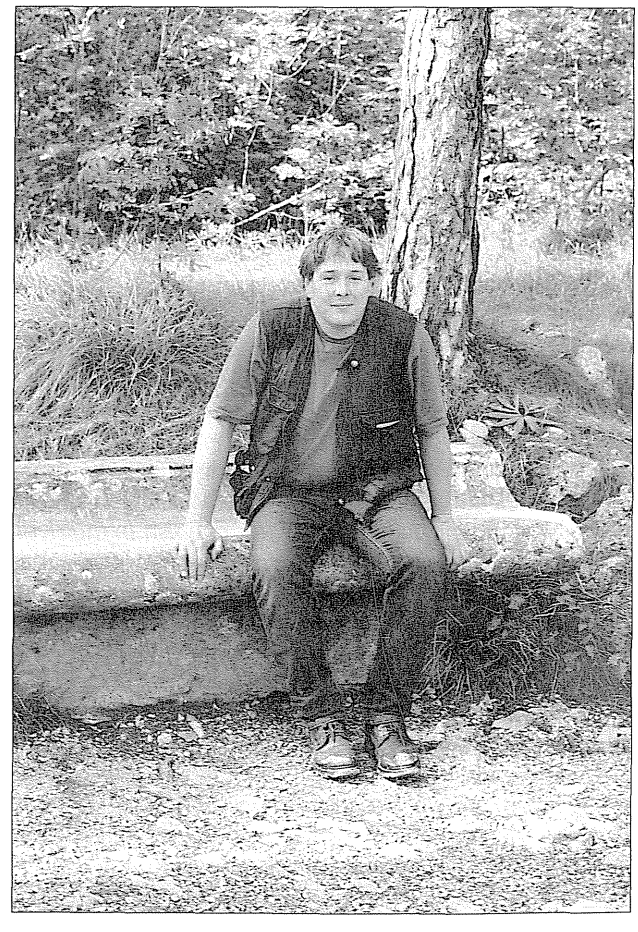
IN MEMORIAM

Obituary

Huw Idwal Griffiths
1958-2002

Huw Idwal Griffiths was born to Martha and Idwal Griffiths in Louth, Lincolnshire, England, on 14 May 1958, twelve years the junior of his sister, Sue. He passed away peacefully in hospital in Hull on 12 June 2002, only one month after he was diagnosed with an advanced cancer of the oesophagus. While suffering increasing medical problems and associated exhaustion which had dogged him since the previous autumn, preventing him from being as active a member of the scientific community as he would normally have been, he made a supreme effort to the end to adopt his usual ebullient character and hide his illness from all but those closest to him. His absolute dedication to his work is evinced most in his determination to complete his current teaching duties; having managed against the odds to finish his lecture courses, he then proceeded to entertain himself when at last confined to home by marking exam papers only two weeks before his death. Huw is survived by his wife Dr. Jane M. Reed, a specialist in diatom analysis, and by their three year old son Thomas, who takes very much after his father.

Huw's keen interest in nature, and animals in particular, developed early on during his childhood. He was a regular visitor to the local pet shop, and had an alarming habit of bringing home the carcasses of reptiles and other vertebrates to examine and sometimes even dissect. It was not until later in life that the opportunity arose to pursue these interests. After secondary school, Huw opted out of university and spent many years going from job to job in search of a purpose in life. He was, amongst other things, a guitarist and singer-songwriter in a band, an interior decorator for BBC television shows and a menial worker in a sausage factory. This wandering period probably contributed to Huw's colourful character, which made him a unique personality as well as an indisputable authority in the scientific community. It was at the age of 27 that he chose zoology as his future career, obtaining a first class BSc Hons degree in zoology from the University of Wales in June 1988. During his undergraduate training Huw was known by his supervisor (with whom he remained in touch until his death) for his boundless enthusiasm, while his outstanding academic merit was reflected in the receipt of the Edith Sheppard and Tattersall Exhibition Awards for best second year work in Zoology and for final year research, respectively. As a promising young scientist Huw continued his studies at the University of Wales where he received an MPhil in April 1992 with a thesis entitled *"The conservation status of the Eurasian badger* (Meles meles *L., 1758) (Carnivora, Mustelidae) in western Europe"*. Not content with this, however, Huw embarked on his PhD research whilst still working on the MPhil, completing his thesis on freshwater ostracod crustacea in May 1995 (University of Wales) entitled: *"The application of freshwater Ostracoda to the reconstruction of Late Quaternary Palaeoenvironments in North-western Europe"*. The PhD and MPhil research were carried out while Huw was employed as a Research Technician at the School of Pure & Applied Biology, University of Wales College of Cardiff (1988-1989), a Research Assistant at the School of History & Archaeology at the same University (1989-1992), and a Research Associate at the Department of Genetics, University of Leeds (1992-1995). Huw then succeeded in obtaining a permanent lectureship in September 1995 in the Department of Geography, University of Hull, being promoted to Senior Lecturer in October 2000.



Huw during the post-conference excursion to Škocjanske jame Cave. Exploratory Workshop "Pattern and Process in the Balkan Biodiversity". September 2001.

Huw's last years in Hull were a happy period in his life. After so many years of tensions, pressures and uncertainties, he finally settled down and, even more importantly, established a family, which remained the focus of his private life. Equally, Huw was very relaxed at work and enjoyed the company of his colleagues and students in Hull. He was the mainstay of a dynamic research group of colleagues, external collaborators and students involved both in the field of environmental change in aquatic ecosystems and that of mammalian conservation. In addition, he loved teaching and enjoyed working with enthusiastic students. I was in personal contact with several of Huw's undergraduate and postgraduate students. They not only regarded him as a brilliant and inspirational lecturer, but simply loved him. As a supervisor, he gave students complete academic freedom but supported them tremendously whenever necessary. Huw's approach to lecturing was as to a theatrical performance, while at the same time ensuring that the scientific content was impeccable. As an ebullient and energetic man, strongly committed to the pursuit of academic excellence, Huw was prepared to spend long hours advising and counselling students at both undergraduate and postgraduate levels, which was deeply appreciated by them. Huw's breadth of interests is reflected well in the range of PhD and MPhil theses he supervised: *"GIS mapping of brown bear distributions in Slovenia"* (Deborah Wilson), *"Status and management of the terrestrial vertebrate fauna of Dominica"* (Kelvin Alie), *"Status and conservation of the bats (Chiroptera) of Jamaica"* (Andrea Donaldson), *"Anthropozoological studies of the effects of ethnic hunting on the fauna of the Gran Chacos, Paraguay, with particular reference to armadillos"* (Silvia Frutos), *"The effects of "set aside" on small mammal communities"* (Jodie Jones), and *"Behavioural studies of the flying fox,* Pteropus *sp."* (Alaric Smith), *"The basis of ostracod shell chemistry in palaeoclimatic reconstruction"* (Kevin Keatings), *"The conservation status of selected Turkish RAMSAR lake sites"* (Sandra Ryan), and *"Night survey for crayfish in the river Wharfe, Yorkshire"* (Stephanie Peay). Huw had also been given many administrative responsibilities and, in the Head of Department's own words, had "responded superbly", in spite of the fact that, due perhaps to his strong professionalism and a seriousness about his work, he disliked much of this "university nonsense" which could waste valuable time spent on more meaningful tasks.

Unlike many scientists, Huw was renowned for the diversity and breadth of his interests, which often gave him a novel outlook on how best to tackle a scientific problem. As noted, these spanned a range of fields from mammalian ecology to freshwater biology and extended in recent times to combining pure and social scientific approaches to solving complex issues. Within this, his major specialisation was to combine modern and ancient datasets from species with excellent fossil records (notably mammals and ostracod crustaceans) to elucidate long-timescale evolutionary and biogeographic patterns, and to use these as analogues in modelling the effects of rapid modern environmental and climate change. The use of freshwater ostracods for the reconstruction of Quaternary palaeoenvironments and recent environmental histories involved studies of both modern and fossil faunas, and also the construction of experimental studies to examine carbon and oxygen isotope uptake in the shells of living ostracods. To achieve these goals, Huw collaborated intensively in multi-proxy, inter-disciplinary research with scientists from the UK (Melanie Leng, Neil Roberts, Mick Frogley, Jane Reed and others), Germany (Antje Schwalb), Spain (Francesc Mezquita-Juanes), Turkey (Selçuk Altınsaçlı), and Slovenia (Lovrenc Lipej, Anton Brancelj, and many more). Huw's genuine interest in the use of matched modern and fossil datasets to elucidate ecological and evolutionary responses to environmental and climatic change in various animal species resulted in additional collaboration with geneticists from the UK (G. R. Carvalho, Angus Davison) and abroad. Finally, recent collaboration with social scientists in Hull (Andy Dawson, David Sibley) had led Huw to become involved with issues related to society and animals, and how animals are perceived by and interact with humans.

It is hard to imagine that someone who started his scientific career relatively late and died so young as Huw did, could achieve such mastery of so many different fields of biology. During his short scientific career, Huw had a prodigious research output; he had become a recognised leading authority on the use of freshwater Ostracoda in palaeoecological work and biological monitoring and, equally, was well known for his work on carnivores. With the publication of an edited volume on mustelid carnivores (Griffiths, 2000) and a co-authored volume on non-marine Ostracods and Quaternary Palaeoenvironments (Griffiths & Holme, 2000), his academic visibility had increased substantially in recent years. What is particularly sad is that Huw did not have time enough to develop fully as a scientist. He died full of ideas and plans and right in the middle of a pile of unfinished work. In spite of Huw's spectacular scientific career and impressive bibliography, he had certainly not yet achieved the peak which was promised by his work to date and by his brilliant mind.

Huw's interest in vertebrate biology was broad, as he refused to be restricted to any particular taxonomic group, geographic region or topic. His related publications ranged from amphibian histology and physiology (possibly reminiscent of his schoolboy's interest in dissecting dead animals) to various aspects of mammalogy. Particularly outstanding was his contribution to mustelid conservation and evolutionary biology. He studied this topic at various scales, from molecular biology at one

level to human-carnivore interactions at another. The European badger was perhaps his favourite, followed by the marble polecat (Huw's contributions to the better understanding of a little known marbled polecat *Vormela peregusna* resulted in him to be appointed a co-chair for the IUCN *Vormela* group), polecats, pine marten, and the European mink. As was characteristic of Huw's entire scientific output, his research in mustelids was original, full of fresh ideas and consequently stimulating for scientists and conservationists. The results of his MPhil Thesis on the conservation status of the Eurasian badger in western Europe have been published as several original scientific papers, while the thesis in its entirety served as the basis for the Report to the Permanent Committee of the Convention on the Conservation of European Wildlife and Natural Habitats at the Council of Europe. This monograph, which appeared in English and in French, is of fundamental importance to the conservation of badgers in Europe and remains a prime example of how such a topic should be approached. In recent years he had become very attracted by the phylogenetic relationships, hybridisation and associated conservational issues related to various *Mustela* species *(M. putorius, M. eversmanni, M. lutreola, M. vison, M. furo),* which required expertise in molecular biology. Huw's reputation resulted in his being an invited member of Small Carnivora IUCN Species Survival Commissions (he also served on the Captive Breeding, and Inland Waters Crustacea Groups) and he was Associate Editor of the Small Carnivore Conservation (previously Mustelid and Viverrid Conservation), the official newsletter of the group. In addition to the managing editor Harry Van Rompaey, Huw was the keystone of the newsletter and was tireless in correcting manuscripts sent by non-English speakers and also in looking up references. When Roland Wirth, the former Chairman of the small carnivore group, decided to step down, Huw was willing to take over also this responsibility in spite of his numerous obligations. In the April 2002 issue of Small Carnivore Conservation (No. 26) Huw as a new chairman formulated priorities for further activities. The tragedy is that his obituary was published only six months later, in the October 2002 issue.

Huw was one of the leading international authority on Quaternary freshwater ostracods. In this case, I feel that Huw was less interested in the animals themselves (as opposed to his devotion to mustelids), than in their value as proxy indicators for past environmental change. This is reflected in his most recent monograph, on reconstructing Quaternary Palaeoenvironments from non-marine ostracod assemblages (Griffiths & Holmes, 2000), which synthesised a huge amount of work. Determined to stabilise taxonomy and nomenclature in order to make palaeoenvironmental, biostratigraphic and palaeobiogeographic studies comparable, Huw had also previously compiled an enormous amount of information on European Quaternary freshwater ostracods and published it in monographic form (Griffiths, 1996), including many papers published in obscure journals and written in various European languages. In addressing the complex issue of reconstructing past environmental change, he was particularly interested in comparing fossil data from a variety of proxies (ostracods, diatoms, pollen, stable isotopes, molecular), and in using modern biological data as a tool for improving interpretation. This was aimed not only at reconstructing processes operating in the past, but also at applying this knowledge to the conservation of modern environments. His study of Macedonian Lake Dojran is a prime example. This relatively small water body, located in the arid south-eastern corner of Macedonia, had suffered recently from a reduction in lake levels which had had a major impact on the ecosystem as well as on the economy of the entire region. Huw enthusiastically organised an international research group of scientists from the UK and Macedonia, successfully sought funding and organised the research. Again, his premature death did not allow him to finish the project in its entirety. However, his paper on the results of the first coring expedition (Griffiths *et al.,* 2001) indicates how carefully the project had been planned.

Evidently, Huw was much attracted by complex issues and one of his last projects was to bring together key workers from different fields concerned with Balkan biodiversity. To this end he co-organised with myself a successful exploratory workshop *"Pattern and Process in Balkan Biodiversity"*, which was sponsored by the European Science Foundation and the Ministry of Science and Research of the Republic of Slovenia. The meeting succeeded in highlighting major shortfalls in our current understanding of the subject. Following the meeting Huw was, as usual, full of ideas on how to overcome this, and was intent on organising a major broad-based, international research project to elucidate patterns of Balkan biodiversity, a project which would have been, in his own words, 'a testimony to my life's work'. We suspect that this gap will remain open, since nobody but Huw could possess a sufficiently broad scientific background and organisational skills to undertake such a demanding task.

Huw's reputation resulted in him being an invited international delegate, invited speaker, organiser and convenor, and member of the organising committee for numerous international meetings. His contribution was invariably original, stimulating to other participants and highly above average. Huw served the academic community also as an assessor for grant applications from national research councils from the UK, Spain, Slovenia and Croatia, as a frequent peer reviewer for various biology and palaeoecology journals and as a PhD examiner at the universities of Valencia (Spain), Hull and York. He was also a Fellow of the Linnean Society of

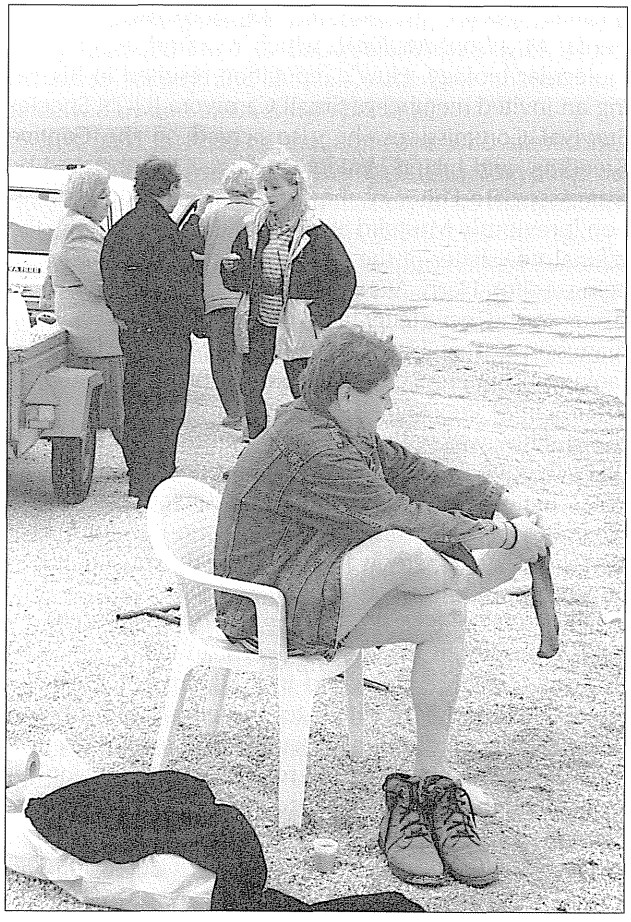
London (FLS; since 1988), Chartered Biologist (CBiol) and Member of the Institute of Biology (MIBiol; since 1992), a Committee Member of the IBG Biogeography Research Group (2000 on), and a member of many learned societies (Royal Geographical Society, Mammal Society of the British Isles, Biogeography Research Group, Quaternary Research Association, Systematics Association, Society for Conservation Biology, *etc.).*

Huw also served on the editorial boards of four scientific journals: *Annales (Annals for Istrian & Mediterranean Studies), Folia Zoologica, Small Carnivore Conservation (Associate Editor),* and *Scopolia.* To this end Huw invested an enormous amount of work and time on improving the quality of written English for manuscripts by non-native English speakers. The editorial board of the *Annales* will miss him deeply also from this point of view.

Although science dominated every aspect of Huw's mind, and was, besides his family, the most important issue in his entire life, he was by no means a boring and narrow-minded scholar. He understood life well, had experienced many things in his previous life and had a strong sense of humour which could often be abrasive but was always well meant. Many of us liked and appreciated collaborating with him. It was not only his broad and deep knowledge of the life sciences and his skill in writing scientific papers which made Huw an exceptional partner. Of no less importance were his friendly approach and his reputation for playing fair. Huw's deep and genuine concern for people is reflected in the manner in which those students with medical or mental problems often flocked to him for support in preference to other lecturers. Huw was always willing to help, no matter whether problems were personal or academic. He was a good listener and his comments, suggestions and advice were all wise. Huw was also capable of judging his scientific achievements objectively, but not in an egocentric way, and respected work done by others no less than his own.

Huw worked hard, starting early and working late, and rarely sitting and doing nothing. There was always a book in his hands or a heap of paper in front of him. He did a tremendous amount of work for his colleagues and friends by commenting on manuscripts and improving written English. In spite of his workaholic lifestyle, Huw threw himself with equal enthusiasm into his social life, making a point of allowing time for relaxation with music and a bottle. Both at work and at home he did not pay much attention to formalities and was renowned for his crumpled T-shirts and shapeless pullovers, which accompanied him not only on field work but also to important meetings with the university authorities or other senior figures. Even in parts of the world where scientists are judged by such formalities rather than by their academic qualifications, however, I never heard anyone protest since Huw's reputation was simply indisputable. Conversely, Huw himself evaluated people solely on the basis of their scientific merit and personality, rather than on their official title. In personal terms, Huw treated technical assistants in the same way as their managers, a trait which was, again, uncommon in many of the regions in which he was working. Huw always did his best to understand the cultural and historical background of locals and to respect this in every way. He was also very keen to master at least a few phrases in the language of the country he was staying in, both to make communication easier and also as a mark of respect.

To get a more complete picture of Huw, one needs also to consider his ethical standards in research work. He never regarded animals simply as tools or scientific objects; he disliked scarifying living creatures for scientific purposes, for example, and always took as little as possible when it was unavoidable. Huw adhered to these standards strictly, whether it be a carnivore or an ostracod at issue. Conservation biology filled an important part of both his private and professional activities. Although Huw perceived the biodiversity crisis as his



Huw preparing for field work on Lake Dojran. Summer 1997.

own personal tragedy, and did the best he could towards the conservation of species, he did not accept green fundamentalism. Being capable of evaluating the situation more objectively, Huw did not approve the ban on fox hunting in the UK, for example. This was not simply because he considered fox hunting to be ethically acceptable, but rather because he believed the benefits of maintaining the landscape for fox hunting outweighed the disadvantages associated with the sport.

Huw had long been closely associated with Slovenian science, since his first visit to the country in summer 1992. His strongest collaboration was with the vertebratologists from the Slovenian Museum of Natural History, but he was also in touch with a number of other researchers with shared interests. Since he found hunters well organised into a national hunter's association (in contrast to the UK), he developed a keen interest in the functioning of this body, the problems it was facing and the possibilities for increasing awareness of nature conservation issues amongst its members. Optimistic as he was, Huw believed firmly that as many groups of people as possible should be actively involved in conservation. Thus, although not interested in hunting *per se*, Huw saw no sense in banning it so long as it was based on a long term and sustainable population management strategy.

Being slightly disappointed that his frequent proposals for upgrading the collaboration between the Slovenian Natural History Museum and the University of Hull did not receive support from the Museum's authorities, Huw enthusiastically joined a small research group of the newly-founded Institute for Biodiversity Studies at the Science and Research Centre of the Republic of Slovenia Koper from its inception in summer 2001. This collaboration was extremely fruitful and resulted in the organisation of the aforementioned *"Pattern and Process in Balkan Biodiversity"* workshop in September 2001, only a few months after the Institute was formed. The meeting was a result of joint efforts on the parts of the Science and Research Centre in Koper and Hull University. For Huw's key role in the preparation of the meeting, as well as for his outstanding scientific output, the Science and Research Centre of the Republic of Slovenia Koper elected him a research associate. Huw was tireless in his efforts to encourage collaboration between British and Slovenian scientists. He sent several students from Hull to undertake field work in Slovenia and was planning more for the future; he was also very willing to provide facilities and training in the UK for young scientists from Slovenia. Having such a brilliant scientist and a keen organiser for a research associate, the Institute for Biodiversity Studies had good reason to be optimistic about its future. It goes without saying how painful the impact of Huw's death has been to us, both at a personal level and because it ruined so many joint plans and prospects. The Institute lost a devoted and loyal friend and we know only too well that we won't ever meet another like him. Huw enriched our lives tremendously and influenced our professional careers, and mine in particular. His name will continue to survive in science as his figure will never fade in the memory of those of us who have had the privilege of being his friend. No matter how little time we had. As a mark of recognition of his merit, Huw was posthumously promoted to Reader in the Department of Geography, Hull, in October 2002. It is also likey that a new ostracod species will be officially named after him in the future, in his honour.

PUBLICATIONS

2002

Griffiths, H. I. A note from the new MVSP SG Chair: Huw Griffiths. *Small Carnivore Conservation* 26: 1.

Schreve, D. C., Bridgeland, D. R., Allen, P., Blackford, J. J., Gleed-Owen, C. P., Griffiths, H. I., Keen, D. H. & White, M. J. Late Middle Pleistocene environments of the Lower Thames: Sedimentology, palaeontology and archaeology of the Corbets Tey Formation at Purfleet, Essex, UK. *Journal of Quaternary Science* 21: 1423-1464.

Kryštufek, B. & Griffiths, H. I. Species richness and rarity in European rodents. *Ecography* 25: 120-128.

Griffiths, H. I., Reed, J. M., Leng, M. J., Ryan, S. & Petkovski, S. The recent palaeoecology and conservation status of Balkan Lake Dojran. *Biological Conservation* 104: 35-49

2001

Altınsaçlı, S. & Griffiths, H. I. The freshwater ostracods *Hungarocypris* and *Leucocythere* from Turkey. *Crustaceana* 74: 681-688.

Altınsaçlı, S. & Griffiths, H. I. Ostracoda (Crustacea) from the Turkish Ramsar site of Lake Kuş (Manyas Gölü). *Aquatic Conservation: Marine and Freshwater Ecosystems* 11: 217-225.

Altınsaçli, S. & Griffiths, H. I. Ostracoda (Crustacea) of Lake Uluabat (Apolyont Gölü) (Bursa Province, Turkey). *Limnologica* 31: 109-117.

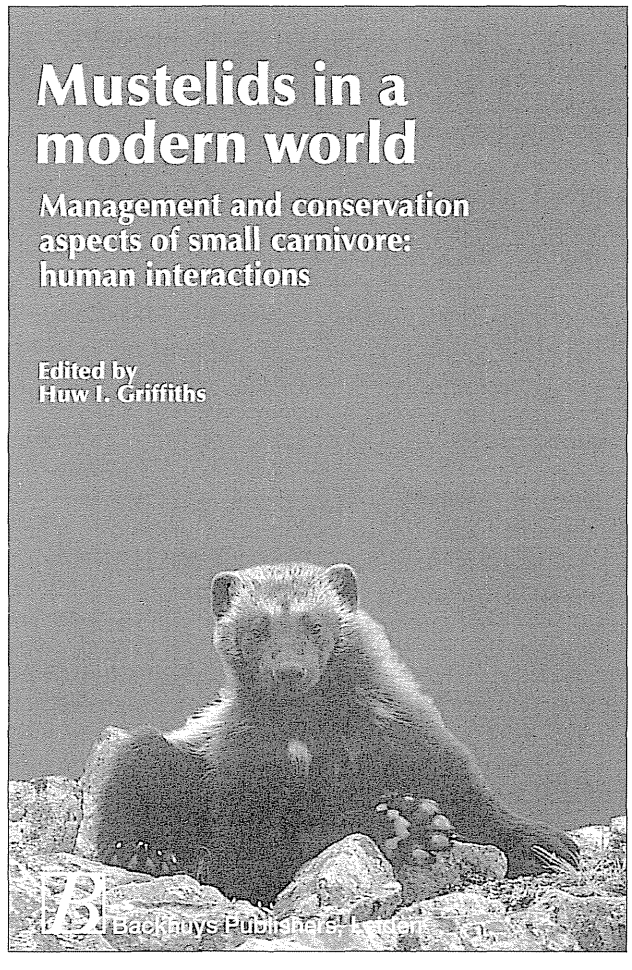
Davison, A., Brookes, R. C., Birks, J. D. S., Messenger, J. E. & Griffiths, H. I. Mitochondrial phylogeography and population history of pine martens *Martes martes* compared with polecats *Mustela putorius*. *Molecular Ecology* 10: 2479-2488.

French, B. I., Mezquita, F. & Griffiths, H. I. Habitat variables affecting occurrence of *Neomys fodiens* (Mammalia, Insectivora) in Kent, UK *Folia Zoologica* 50: 99-105.

Frogley, M. R., Griffiths, H. I. & Heaton, T. H. E. Historical biogeography and Late Quaternary environmental change at Lake Pamvotis, Ioannina (NW Greece); evidence from ostracods. *Journal of Biogeography* 28: 745-756.
Griffiths, H. I. Ostracod evolution and extinction - its biostratigraphic value in the European Quaternary. *Quaternary Science Reviews* 20: 1743-1751.
Griffiths, H. I. & Reed. J. M. Using palaeolimnological techniques for biomonitoring: the case of Balkan Lake Dojran. *Interaction between fish and birds: implications for management, HIFI, Hull, April, 2001*: unpaginated.
Griffiths, H. I., Reed, J. M., Leng, M. J., Ryan, S. & Petkovski, S. Combining ecology and palaeoecology: Balkan Lake Dojran. *Modern analogues and their value for the interpretation of past environments - QRA Annual Discussion Meeting, Cardiff*: 5.
Griffiths, H. I., Schwalb, A. & Stevens, L. R. Evironmental change in NE Iran: the Holocene ostracod fauna of Lake Mirabad. *The Holocene* 11: 755-762.
Leroy, S., Kazancı, N., Ileri, Ö., Kibar, M. & Griffiths, H. I. An abrupt (seismic) event recorded in Lake Manyas (N-W Turkey) sediment dating from the Byzantine period. *Environmental changes and the rise and fall of the civilizations (Asian Lake Drilling Programme Meeting, Kyoto, Japan, November, 2001). Monsoon* 3: 53-59.
Leroy, S., Kazancı, N., Ileri, Ö., Kibar, M., McGee, E. & Griffiths, H. I. An abrupt (seismic) event recorded in Lake Manyas (N-W Turkey) sediment dating from the Byzantine period. In: *High-resolution lake sediment records in climate and environment variability studies (6th Workshop of the European Lake Drilling Programme), Potsdam, May 2001. Terra Nostra*, 2001 (3): 125-131.
Matzke-Karasz, R., Horne, D. C., Janz, H., Griffiths, H. I., Hutchinson, W. F. & Preece, R. C. 5000-year-old spermatozoa in Quaternary Ostracoda (Crustacea). *Naturwissenschaften* 88: 268-272.
Ryan, S. & Griffiths, H. I. The decline and probable extinction of *Graecoanatolica macedonica* (Gastropoda, Orientallnidae) in Balkan Lake Dojran. *Journal of Conchology* 37: 261-266.
Mezquita, F., Griffiths, H. I., Domínguez, M. I. & Lozano-Quilis, M. A. Ostracoda (Crustacea) from brooks as ecological indicators: a case study from València, E. Spain. *Archiv für Hydrobiologie* 150: 545-560.

2000

Davison, A., Birks, J. D. S., Maran, T., Macdonald, D. W., Sidorovich, V. E. & Griffiths, H. I. Hybridization and the phylogenetic relationship between polecats, domestic ferrets, and European mink. In: H. I. Griffiths (ed.), *Mustelids in a Modern World*: 153-162. Leiden; Dr. W. Backhuys.



Huw's most important single contribution to small carnivore biology and conservation must be the edited volume on mustelid carnivores (Griffiths, 2000) which originated from the very successful and entertaining workshop which Huw convened during the Euro-American Mammal Congress in Santiago de Compostela, Spain, in July 1998.

Davison, A., Griffiths, H. I., Brookes, R., Maran, T., Macdonald, D. W., Sidorovich, V., Kitchener, A. C., Irizar, I., Villate, I., González-Esteban, J., Ceña, J. C., Ceña, A., Moya, I., Miñanao, S. P. Mitochondrial DNA and palaeontological evidence for the origins of endangered European mink, *Mustela lutreola*. *Animal Conservation* 3: 345-355.
Griffiths, H. I. (Ed.) *Mustelids in a Modern World. Conservation and Management Aspects of Small Carnivore: Human interactions*. Leiden; Dr. W. Backhuys, ISBN 90-5782-066-8.
Griffiths, H. I. & Holmes, J. A. *Non-marine Ostracods and Quaternary Palaeoenvironments (QRA Technical Guide No. 8)*. London; Quaternary Research Association.

Griffiths, H. I., Poulter, I. & Sibley, D. Feral cats in the city. In: C. Philo & C. Wilbert (Eds.), *Animal spaces, beastly places*: 56-70. London; Routledge.

Griffiths, H. I., Reed, J. M., Leng, M. J., Ryan, S. & Petkovski, S. The recent and palaeo-ecology of Balkan Lake Dojran. In: *Programa Científico y Libro de Résumenes: X Congreso de la Asocación Española de Limnología y II Congreso Ibérico de Limnología, Valencia, 12-16 June, 2000*: 275.

Howard, A. J., Keen, D. H., Mighall, T. M., Field, M. H., Coope, G. R., Griffiths, H. I. & Macklin, M. G. Early Holocene environments of the River Ure near Ripon, North Yorkshire, UK. *Proceedings of the Yorkshire Geological Society* 53: 31-42.

Kryštufek, B., Davison, A. & Griffiths, H. I. Evolutionary biogeography of *Neomys* water shrews in the Western Palaearctic. *Canadian Journal of Zoology* 78: 1616-1625.

Kryštufek, B. & Griffiths, H. I. Cranial differentiation in *Neomys* water shrews. *Folia Zoologica* 49: 81-87.

Paunović, M., Mraković, M., Abel. H. V. & Griffiths, H. I. The marbled polecat, *Vormela peregusna* (Güldenstaedt, 1770), in FR Yugoslavia and elsewhere In: H. I. Griffiths (ed.), *Mustelids in a Modern World*: 321-329. Leiden; Dr. W. Backhuys.

Preece, R. C., Bridgland, D. R., Lewis, S. G., Parfitt, S. A. & Griffiths, H. I. Beeches Pit, West Stow, Suffolk (TL 798719). In: S. G. Lewis, C. A. Whiteman & R. C. Preece (eds.), *The Quaternary of Norfolk and Suffolk: Field Guide*: 185-195. London; Quaternary Reseacrh Association.

Schön, I., Gandolfi, A., Di Masso, E., Rossi, V., Griffiths H. I., Martens, K. & Butlin, R. K. Persistence of asexuality through mixed reproduction in *Eucypris virens* (Crustacea, Ostracoda). *Heredity* 84: 161-169.

Schwalb, A., Burns, S. J., Griffiths, H. I. & Wessels, M. Ostracode assemblages and stable isotopes from Lake Constance: a 16 kyr record of faunal succession and climate for the central Alps. *DEUQUA 2000, Eiszeitalter und Alltag, Kurzfassungen der Vorträge und Posters*: 72.

1999

Davison, A., Birks, J. D. S., Griffiths, H. I., Kitchener, A., Biggins, D. & Butlin, R. K. Hybridization and the phylogenetic relationship between polecats *(Mustela putorius, M. eversmanni)* and ferrets *(M. furo). Biological Conservation* 87: 155-161.

Griffiths, H. I. Biogeography and ostracod biostatigraphy. *Recent adavances in Quaternary Biostratigraphy, QRA Annual Discussion Meeting, Cambridge, January, 1999*: 8-9 (Abstract).

Griffiths, H. I. Freshwater Ostracoda from the Mesolithic lake site at Lough Boora (Co. Offaly, Ireland). *Irish Journal of Earth Sciences* 17: 39-49.

Kryštufek, B. & Griffiths, H. I. Mediterranean *v.* continental small mammal communities and the environmental degradation of the Dinaric Alps. *Journal of Biogeography* 26: 167-177.

Holmes, J. A. & Griffiths, H. I. Ostracoda from Star Carr. In: P. Mellars & S.P. Day (Eds.), *Star Carr in context: new archaeological and palaeoenvironmental investigations at the early Mesolithic site of Star Carr, North Yorkshire*: 175-178. Cambridge; Mcdonald Institute Monographs.

Mezquita, F., Griffiths, H. I., Sanz, S., Soria, J. M., & Piñón, A. Ecology and distribution of ostracods associated with flowing waters in the eastern Ibernian Peninsula. *Journal of Crustacean Biology* 19: 344-354.

Roberts, N., Black, S., Boyer, P., Eastwood, W. J., Griffiths, H. I., Leng, M, Parish, R., Reed, J. M., Twigg, D. and Yiğitbasioğlu, H. Chronology and Stratigraphy of Late Quaternary sediments in the Konya Basin, Turkey: results from the KOPAL project. *Quaternary Science Review* 18: 611-630.

Schwalb, A., Burns, S. J., Griffiths, H. I. & Wessels, M. Ostracod assemblages and stable isotopes from Lake Constance: A 16 kyr record of faunal succession and climate. *European Union of Geosciences, Journal of Conference Abstracts*, 4: 192-193.

1998

Butlin, R. K., Schön, I. & Griffiths, H. I. Introduction to reproductive modes. In: K. Martens (Ed.). *Sex and Parthenogenesis: evolutionary ecology of reproduction in non-marine Ostracoda (Crustacea):* 1-24. Leiden; Backhuys.

Davison, A., Birks, J., Griffiths, H. I., Kitchener, A. C. & Butlin, R. K. Hybridization and the phylogenetic relationship between polecats, domestic ferrets and European mink. *Abstracts Euro-American Mammal Congress, Santiago de Compostela, Spain, July 1998*: A105.

Griffiths, H. I. Conservation and Balkan biodiversity (plenary lecture). In: S. Petkovski, V. Siderovska, B. Curčić, H. Griffiths & W. Haberl (Organisers), *BIOECCO 2: 2nd Int. Cong. Biodiversity, Ecology and Conservation of the Balkan fauna, Ohrid, Sept. 1998*: 42-46.

Griffiths, H. I., Butlin, R. K. & Geiger, W. Considerations of timescale effects in the evolution of parthenogenesis in freshwater Ostracoda. In: S. Crasquin, E. Braccini & F. Lethiers (eds.), *What about Ostracoda! Bulletin des Centres de Recherches Exploration-Production Elf-Aquitaine, Mémoire* 20: 27-32.

Griffiths, H. I. & Horne, D. J. Fossil distribution of reproductive modes. In: K. Martens (Ed.), *Sex and parthenogenesis: evolutionary ecology of reproductive modes in non-marine Ostracoda (Crustacea)*: 101-118. Leiden; Backhuys.

Griffiths, H. I., Pietrzeniuk, E., Fuhrmann, R., Lennon, J. J., Martens, K. & Evans, J. G. *Tonnacypris glacialis* (Ostracoda, Cyprididae): taxonomic position, (palaeo)-ecology and zoogeography. *Journal of Biogeography* 25: 515-526.

Griffiths, H. I., Reed, J. M. & Petkovski, S. Environmental change at Lake Dojran: preliminary data from benthos and sediments. In: In: S. Petkovski, V. Siderovska, B. Curčić, H. Griffiths & W. Haberl (Organiers), *BIOECCO 2: 2nd Int. Cong. Biodiversity, Ecology and Conservation of the Balkan fauna, Ohrid, Sept. 1998*: 73.

Griffiths, H. I. & Thomas, D. H. *La conservation et la gestion du blaireau d'Europe (Meles meles). (Sauvegard de la Nature No 90).* Strasbourg; Council of Europe Press, ISBN 92-871-3446-4.

Kryštufek, B., Davison, A. & Griffiths, H. I. Evolutionary relationships among the Palaearctic water shrews (genus *Neomys*). *Abstracts 78th Annual Meeting of the American Society of Mammalogists, Blacksburg (Va.), June, 1998*: A169.

Martens, K., Horne, D. J. & Griffiths, H. I. Age and diversity of non-marine ostracods. In: K. Martens (Ed.), *Sex and Parthenogenesis: evolutionary ecology of reproduction in non-marine Ostracoda (Ostracoda):* 37-35. Leiden; Backhuys.

Rossi, V., Gentile, G., Otero, M., Pospisil, P., Baltanás, A., Geiger, W., Griffiths, H. I. & Menozzi, P. Comparison of genetic variability in two species with geographic parthenogenesis: *Eucypris virens* and *Limnocythere inopinata*. In: S. Crasquin, E. Braccini & F. Lethiers (eds.), *What about Ostracoda! Bulletin des Centres de Recherches Exploration-Production Elf-Aquitaine, Mémoire* 20: 427 (Abstract).

Rossi, V., Gentile, G., Geiger, W., Griffiths, H. I., Martens, K. & Menozzi, P. Genetic structure of European populations of *Darwinula stevensoni* (Crustacea, Ostracoda). In: S. Crasquin, E. Braccini & F. Lethiers (eds.), *What about Ostracoda! Bulletin des Centres de Recherches Exploration-Production Elf-Aquitaine, Mémoire* 20: 426-427 (Abstract).

Schön, I., Butlin, R. K., Griffiths, H. I. & Martens, K. Slow molecular evolution in an ancient asexual ostracod. *Proceedings of the Royal Society of London (Series B)* 265: 235-242.

Schoen, I., Di Masso, E., Gandolfi, A., Griffiths, H. I., Verheyen, E. & Butlin, R. K. The application of molecular techniques to the study of ostracods. In: S. Crasquin, E. Braccini & F. Lethiers (eds.), *What about Ostracoda! Bulletin des Centres de Recherches Exploration-Production Elf-Aquitaine, Mémoire* 20: 47-52.

Smith, A. B. & Griffiths, H. I. Apparent recovery from a broken femur in the Indian flying fox, *Pteropus giganteus* (Chiroptera, Pteropodidae). *Mammalia* 62: 457-460.

1997

Griffiths, H. I. & Brancelj, A. Preliminary list of freshwater Ostracoda (Crustacea) from Slovenia. *Annales - Annals of Istrian and Mediterranean Studies* 9 (1996): 201-210.

Griffiths, H. I. & Thomas, D. H. *The conservation and management of the European Badger (Meles meles). (Council of Europe Nature & Environment Monograph No 90).* Strasbourg; Council of Europe Press. ISBN 92-871-3447-2.

Keen, D. H., Coope, G. R., Jones, R. L., Field, M. H., Griffiths, H. I., Lewis, S. G. & Bowen, D. Q. Middle Pleistocene deposits at Frog Hall Pit, Stretton-on-Dunsmore, Warwickshire, English Midlands, and their implications for the age of the type Wolstonian. *Journal of Quaternary Science* 12: 183-208.

Reed, J. M., Black, S., Eastwood, W. J., Griffiths, H. I., Lamb, H. F., Leng, M., Parish, R. & Roberts, N. Late Quaternary limnological and climatic changes in the Konya Basin, Turkey. *Int. Symp. on the Late Quaternary in the Eastern Mediterranean, Ankara, April, 1997.*

1996

Griffiths, H. I. Conservation, welfare, and caring for the wild. *Small Carnivore Conservation* 15: 14-16.

Griffiths, H. I. European Quaternary freshwater Ostracoda; A biostratigraphic and palaeobiogeographic primer. *Scopolia* 34 (1995): 1-168.

Griffiths, H. I. & Brancelj, A. The (palaeo)-biogeography of *Candona bimucronata*: an unusual candonid ostracod from the Balkans. *Crustaceana* 69: 882-889.

Griffiths, H. I., Butlin, R. K. & Geiger, W. Considerations of timescale effects in the evolution of parthenogenesis in freshwater Ostracoda. In: *Abstracts 3rd European Ostracodologists meeting, Paris - Bierville, July 1996*: 31.

Griffiths, H. I., Davison, A. & Birks, J. Species reintroductions. *Conservation Biology* 10: 923.

Griffiths, H. I., Pillidge, K. E., Hill, C. J., Evans, J. G. & Learner, M. A. Ostracod gradients in a calcareous stream: implications for the palaeoecological interpretation of tufas and travertines. *Limnologica* 26: 49-61.

Kryštufek, B., Griffiths, H. I. & Vohralík, V. The status and use of *Terricola* FATIO, 1867 in the taxonomy of Palaearctic "pine voles" *(Pitymys)* (Rodentia, Arvicolinae). *Bulletin de l'Institure Royal des Sciences Naturelles de Belgique, Biologie* 66: 237-240.

Rossi, V., Gentile, G., Otero, M., Pospisil, P., Baltanás, A., Geiger, W., Griffiths, H. I. & Menozzi, P. Comparison of genetic variability in two species with geographic parthenogenesis: *Eucypris virens* and *Limnocythere inopinata* (Crustacea, Ostracoda). In: *Abstracts 3rd European Ostracologists' Meeting, Paris - Bierville, July 1996*: 69.

Rossi, V., Gentile, G., Geiger, W., Griffiths, H. I., Martens, K. & Menozzi, P. Genetic structure of European populations of *Darwinula stevensoni* (Crustacea, Ostracoda). In: *Abstracts 3rd European Ostracologists' Meeting, Paris - Bierville, July 1996*: 67.

Schön, I. & Griffiths, H. I. Molecular techniques and small carnivore conservation. *Small Carnivore Conservation* 14: 2-6.

Schoen, I., Di Masso, E., Gandolfi, A., Griffiths, H. I. & Butlin, R. K. The application of molecular techniques to the study of ostracods. In: *Abstracts 3rd European Ostracodologists meeting, Paris - Bierville, July 1996*: 72.

1995

Griffiths, H. I. An electron microscopic study of gill epithelium in *Ambystoma mexicanum* (Amphibia, Urodela). *Folia Zoologica* 44: 279-283.

Griffiths, H. I. & Butlin, R. K. A timescale for sex *vs.* parthenogenesis - evidence from Holocene subfossil ostracods. *Proceedings of the Royal Society of London (Series B)* 260: 65-71.

Griffiths, H. I. & Evans, J. G. The Late-glacial and early Holocene colonisation of the British Isles by freshwater ostracods. In: J. Ríha (Ed.), *Ostracoda and Biostratigraphy:* 291-302. Rotterdam; A. A. Balkema.

Griffiths, H. I. & Evans, J. G. Seasonal dynamics of *Cypria ophthalmica* (Jurine) in permanent and temporary subdivisions of a temperate pond. In: J. Ríha (Ed.), *Ostracoda and Biostratigraphy*: 444. Rotterdam; A. A. Balkema (Abstract).

Griffiths, H. I. & Evans, J. G. An annotated check-list of British Pleistocene, Holocene and Modern freshwater Ostracoda. *Journal of Micropalaeontology* 14: 59-65.

Griffiths, H. I. & Pedley, H. M. Did changes in late last glacial and early Holocene atmosperic CO_2 availability play a role in episodic tufa formation? *The Holocene* 5: 238-242.

Kontrovitz, M., Slack., J. & Griffiths, H. I. Ostracoda from the moats of a Medieval Castle, Scotland. *Abstracts with Programmes, Annual Meeting Geological Society of America, New Orleans, November, 1995. Geological Society of America*, 27 (6): A-415.

1994

Bego, F. & Griffiths, H. I. Preliminary data on the bats (Mammalia, Chiroptera) of Albania. *Studies in Speleology* 9: 21-25.

Butlin, R. K. & Griffiths, H. I. DNA sequence analysis and the problem of parthenogenesis. In: D. J. Horne & K. Martens (Eds.), *The Evolutionary Ecology of Reproductive Modes in Non-marine Ostracoda*: 37-42. London; University of Greenwich Press.

Evans, J. G. & Griffiths, H. I. Investigations towards the reconstruction of the Late-glacial environment at Lurga, S. E. Burren. II. Mollusc and ostracod evidence (Site P1). In: M. O'Connell (Ed.), *Boireann, Co. an Chláir/Burren, Co. Clare (Field Guide No. 18)* (2nd ed.): 48-50. Galway; Irish Association for Quaternary Studies.

Griffiths, H. I. The effects upon badgers (*Meles meles*) of the activities of a single, persistent poacher. *Animal Welfare* 3: 219-225.

Griffiths, H. I. Pre- and early historic records of the Eurasian badger *Meles meles* (L., 1758) (Carnivora, Mustelidae), in Britain. *Studies in Speleology* 9: 27-36.

Griffiths, H. I. & Butlin, R. K. *Darwinula stevensoni*: a review of the biology of a persistant parthenogen. In: D. J. Horne & K. Martens (Eds.), *The Evolutionary Ecology of Reproductive Modes in Non-marine Ostracoda*: 27-36. London; University of Greenwich Press.

Griffiths, H. I. & Evans, J. G. Infestation of the freshwater Ostracod *Cypria ophthalmica* (JURINE) by the Peritrich *Nüchterleinella corneliae* (MATTHES). *Archiv für Protistenkunde* 144: 23-25.

Griffiths, H. I. & Evans, J. G. The Late Last glacial and early Holocene colonisation of the British Isles by freshwater ostracods. *Abstracts 12th International Conference on Ostracoda, Prague, July 1994*: unpaginated.

Griffiths, H. I. & Evans, J. G. Seasonal dynmaics of *Cypria ophthalmica* (Jurine) in permanent and temporary subdivisons of a temperate pond. *Abstracts 12th International Conference on Ostracoda, Prague, July 1994*: unpaginated.

Griffiths, H. I., Ringwood, V. & Evans, J. G. Weichselian Late-glacial and early Holocene molluscan and ostracod sequences from lake sediments at Stellmoor, north Germany. *Archiv für Hydrobiologie* 99 (S): 357-380.

Kryštufek, B., Griffiths, H. I. & Grubesić, M. Some new information on the distributions of the American and European mink *(Mustela* spp.) in the former Yugoslavia. *Small Carnivore Conservation*, 10: 2-3.

Taylor, D. M., Griffiths, H. I., Pedley, H. M. & Prince, I. Radiocarbon-dated Holocene pollen and ostracod sequences from barrage tufa-dammed fluvial systems in the White Peak, Derbyshire, UK. *The Holocene* 4: 356-364.

1993

Butlin, R. K. & Griffiths, H. I. Ageing without sex? *Nature* 364: 680.

Evans, J. G. & Griffiths, H. I. Holocene mollusc and ostracod sequences: their potential for examining short-timescale evolution. In: D. R. Lees & D. Walker (Eds.), *Evolutionary Patterns and Processes*: 125-137. London; Academic Press.

Evans, J. G. & Griffiths, H. I. Mollusc and ostracod evidence. In: W. P. Warren & M. O'Connell (eds.), *An Boireann / The Burren (Field Guide No. 15):* 52-54. Galway; Irish Association for Quaternary Studies.

Griffiths, H. I. The hunting of badgers in Britain: past, present and future? In: *National Federation of Badger Groups Annual Conference, Preston, September 1993*: 61-68. London; NFBG.
Griffiths, H. I. The Eurasian badger, *Meles meles* (L., 1758), as a commodity species. *Journal of Zoology* 230: 340-342.
Griffiths, H. I. Badger game-bag data estimates of badger (*Meles meles*) population sizes in Europe. *Small Carnivore Conservation* 9: 9-10.
Griffiths, H. I., Griffiths, C. A. & Thomas, D. H. *The Badger,* Meles meles (L., 1758)*: An Assessment of the Population Status, Conservation Needs, and Management Requirements of the Species in the Western Palaearctic.* Report to the Permanent Committee of the Convention on the Conservation of European Wildlife and Natural Habitats. Strasbourg; Council of Europe. 97 pp. (also available in French).
Griffiths, H. I. & Kryštufek, B. Hunting pressures and badgers *Meles meles*: patterns and possible futures. *Lutra* 36: 49-61.
Griffiths, H. I., Martin, D. S., Shine, A. J. & Evans, J. G. The ostracod fauna (Crustacea, Ostracoda) of the profundal benthos of Loch Ness. *Hydrobiologia* 254: 111-117.
Griffiths, H. I. & Martin, D. S. The spatial distribution of benthic ostracods in the profundal zone of Loch Ness. In: *Collected Papers on Loch Ness Research Initiated by the Loch Ness and Morar Project. The Scottish Naturalist* 105: 137-147.
Griffiths, H. I. & Mount, R. Ostracods, pp. 181-184. In: An environmental history of the Upper Kennet Valley, Wiltshire, for the last 10,000 years, by J. G. Evans, S. Limbrey, R. Mount & I. Máté. *Proceedings of the Prehistoric Society* 59: 139-195.
Griffiths, H. I., Pillidge, K. E., Hill, C. J., Evans, J. G. & Learner, M. A. Ostracod gradients in a calcareous stream: implications for the palaeoecological interpretation of tufas and travertines. In: M. C. Keen (ed.), *Preprints 2nd European Ostracodologists' Meeting, Glasgow, July 1993*: 109-121.
Griffiths, H. I., Rouse, A. J. & Evans, J. G. Processing freshwater ostracods from archaeological deposits, with a key to the valves of the major British genera. *Circaea – the Journal of the Association for Environmental Archaeology* 10: 53-62.
Griffiths, H. I. & Thomas, D. H. The status of the badger *Meles meles* (L. 1758) (Carnivora, Mustelidae) in Europe. *Mammal Review* 23: 17-58.
Walker, M. J. C., Griffiths, H. I., Ringwood, V. & Evans, J. G. An early-Holocene pollen, mollusc and ostracod sequence from lake marl at Llangorse Lake, South Wales, UK. *The Holocene* 3: 138-149.

1992

Griffiths, H. I. Police prosecutions and badger persecution in England and Wales. *Animal Welfare* 1: 291-296.
Griffiths, H. I. & Evans, J. G. A simple notation scheme to describe time-averaged ostracod assemblages (Crustacea, Ostracoda) by their taxonomic composition. *Journal of Micropalaeontology* 11: 31-35.
Griffiths, H. I. & Evans, J. G. *Potamocypris arcuata* (SARS, 1903) (Ostracoda) new to Britain. *Crustaceana* 62: 110-112.
Griffiths, H. I. & Thomas, D. H. Aquatic oxygen conformity in the Mexican axolotl *Ambystoma mexicanum*. *Herpetological Journal* 2: 1-4.

1991

Griffiths, H. I. *On the hunting of badgers.* Brynna; Piglet Press.
Griffiths, H. I. Statut actuel du blaireau *(Meles meles)* en Europe: chasse et protection. *Cahiers d'Ethologie* 11: 67-80.
Griffiths, H. I. The hunting of badgers in Europe. In: *National Federation of Badger Groups Annual Conference, Harper Adams Agricultural College, September 1991*: 26-32. London; NFBG.
Griffiths, H. I. & Evans, J. G. Some freshwater ostracods (Crustacea, Ostracoda) from South Wales. *Freshwater Forum* 1: 64-72.

1990

Griffiths, H. I., Hicks, D. C. & Morris, V. The distribution and status of the badger in Glamorgan, Wales. *Mustelid and Viverrid Conservation* 2: 8-9.

1989

Griffiths, H. I. & Thomas, D. H. What is the status of the Mexican axolotl? *Bulletin of the British Herpetological Society* 26: 3-5.

In Press

Griffiths, H. I. Non-marine ostracods as indicator taxa in ancient wetlands. In: M. C. Lillie (ed.), *Wetland archaeology and environments: local issues, global perspectives.* London; Rotledge.
Altınsaçlı, S. & Griffiths, H. I. A review of the occurrence and distribution of recent non-marine Ostracoda in Turkey. *Zoology in the Middle East.*
Leroy, S., Kazancı, N., Ileri, Ö., Kibar, M., Emre, O., McGee, E. & Griffiths, H. I. Abrupt environmental changes within a Holocene lacustrine sequence south of the Marmara Sea (Lake Manyas, N-W Turkey): possible links with seismic events. *Marine Geology.*

Reid, V. A., Carvalho, G. R., George, D. G. & Griffiths, H. I. A technique for the molecular genetic analysis of Daphnia restiong eggs from sub-recent lake sediments. *Journal of Paleolimnology.*

Frogley, M. R., Griffiths, H. I. & Martens, K. Recent and fossil ostracodes from ancient lakes. In: J. A. Holmes & A. Chivas (eds.), *The Ostracoda: applications in Quaternary research (Geophysical Monograph Number 131):* Washington (DC); American Geophysical Union, 2002.

Submitted

Davies, P. & Griffiths, H. I. Molluscan and ostracod biostratigraphy of early to Mid Holocene paludal tufa deposits within the valley fill of the River Test at Bossington, Hampshire, UK. *The Holocene.*

Griffiths, H. I. & Cuzin, F. Ferret, *Mustela furo.* In: J. Kingdon & T. Butynski (eds.), *Mammals of Africa, Vol. 5.* London; Academic Press.

Ferrier, G., Kryštufek, B., Griffiths, H. I. & Wilson, D. Management of bear population dynamics in Slovenia using GIS and remote sensing. *Conservation Biology.*

Boris Kryštufek

KAZALO K SLIKAM NA OVITKU

SLIKA NA NASLOVNICI: Slegurji *(Monticola saxatilis)* radi posedajo na kupih kamenja. (Foto: I. Geister)

Sl. 1: Zaraščanje in izsuševanje kraških kalov še dodatno pospešujejo človekovi posegi. Na sliki je kal ob glavni cesti med Ljubljano in Koprom pri Petrinjah. (Foto: D. Podgornik)

Sl. 2: Tipična oblika združbe *Homogyno Nardetum* na Ribniškem Pohorju. (Foto: S. Škornik)

Sl. 3: Na travnati planoti v Čičariji gnezdi prek 30 vrst ptic. Na sliki so ostaline kultivirane pokrajine v Zalipniku. (Foto: I. Geister)

Sl. 4: Peščena puščava v Alžiriji v bližini oaze Ouargla. Novejše raziskave kažejo, da imajo vnosi puščavskega peska v Sredozemsko morje velik vpliv na biogeokemijske in biološke procese. (Foto: D. Podgornik)

Sl. 5: Pavji knez *(Thalassoma pavo)* je toploljubna vrsta ribe, ki v zadnjih letih širi svoj areal razširjenosti proti severu. (Foto: M. Richter)

Sl. 6: Vrtača sredi suhih kraških travišč na otoku Cresu. Zaradi debelejšega sloja prsti so tradicionalno rabile kot kmetijske površine. Tam, kjer so kulture opustili, se zaradi rodovitnejše prsti in več vlage hitro zaraščajo z grmi in drevesi. (Foto: D. Podgornik)

Sl. 7: Vrtača na ovršju planote v Čičariji se zarašča. (Foto: I. Geister)

Sl. 8: Puščava v Tuniziji v bližini Nefte s kamelami v ozadju. (Foto: D. Podgornik)

INDEX TO PICTURES ON THE COVER

FRONT COVER: Rock Thrushes *(Monticola saxatilis)* love to perch on heaps of stones. (Photo: I. Geister)

Fig. 1: The rapid natural succession of overgrowing and drying out of karst ponds is being further hastened by human destructive activities. This particular karst pond is situated along the Ljubljana-Koper high road near the village of Petrinje. (Photo: D. Podgornik)

Fig. 2: A typical form of the association *Homogyno Nardetum* at Ribniško Pohorje. (Photo: S. Škornik)

Fig. 3: On the grassy plateau of Čičarija, over 30 bird species are known to breed. The picture presents the remains of cultural landscape at Zalipnik. (Photo: I. Geister)

Fig. 4: Sand desert in Algeria in the vicinity of the Ouargla oasis. Some of the recently carried out investigations have shown that desert sand reaching the Mediterranean Sea has a great impact on the biogeochmical and biological processes. (Photo: D. Podgornik)

Fig. 5: Ornate Wrasse *(Thalassoma pavo)* is a thermophilous fish species, which has in the last few years extend its range towards the north. (Photo: M. Richter)

Fig. 6: Karst sinkhole in the midst of dry karst grassland on the island of Cres. Owing to the thicker layer of soil in this type of holes called *doline*, they were traditionally used as arable tracts of land. In places where soil cultivation has been abandoned, the *doline* are being rapidly overgrown with bushes and trees. (Photo: D. Podgornik)

Fig. 7: An increasingly overgrown karst sinkhole in the upper part of the Čičarija plateau. (Photo: I. Geister)

Fig. 8: A Tunisian desert near Nefta with camels in the background. (Photo: D. Podgornik)

NAVODILA AVTORJEM

1. ***ANNALES:*** *Anali za istrske in mediteranske študije - Annali di Studi istriani e mediterranei - Annals for Istran and Mediterranean Studies* (do 5. številke: *Anali Koprskega primorja in bližnjih pokrajin - Annali del Litorale capodistriano e delle regioni vicine - Annals of the Koper Littoral and Neighbouring Regions)* je znanstvena in strokovna interdisciplinarna revija humanističnih, družboslovnih in naravoslovnih vsebin v podnaslovu opredeljenega geografskega območja.

2. Sprejemamo prispevke v slovenskem, italijanskem, hrvaškem in angleškem jeziku. Uredništvo ima pravico prispevke jezikovno lektorirati.

3. Prispevki naj obsegajo največ 24 enostransko tipkanih strani s po 30 vrsticami. Na levi pustite 3 do 4 cm širok rob. Zaželjeno je tudi (originalno) slikovno gradivo, še posebno pa oddaja prispevka na računalniški disketi v programih za PC (osebne) računalnike.

4. Naslovna stran tipkopisa naj vsebuje naslov in podnaslov prispevka, ime in priimek avtorja, avtorjeve nazive in akademske naslove, ime in naslov inštitucije, kjer je zaposlen, oz. domači naslov vključno s poštno številko in morebitnim naslovom elektronske pošte.

Uredništvo razvršča prispevke v naslednje **kategorije:**

Izvirni znanstveni članki vsebujejo izvirne rezultate lastnih raziskav, ki še niso bili objavljeni. Dela pošlje uredništvo v recenzijo. Avtor se obvezuje, da prispevka ne bo objavil drugje.

Pregledni članki imajo značaj izvirnih del. To so natančni in kritični pregledi literature iz posameznih zanimivih strokovnih področij.

Predhodno sporočilo in *Gradiva* imajo ravno tako značaj izvirnih del.

Strokovni članki prikazujejo rezultate strokovnih raziskav. Tudi te prispevke uredništvo pošlje v recenzijo in avtor se obveže, da prispevka ne bo objavil drugje.

Poročila vsebujejo krajše znanstvene informacije o zaključenih raziskovanjih ali kratek opis strokovnih in znanstvenih knjig ali srečanj. Taki prispevki ne smejo presegati 5 strani.

Mladinske raziskovalne naloge morajo biti urejene kot strokovna dela.

Komentarji so namenjeni aktualnostim s strokovnega področja. Ne smejo presegati 2 strani.

Obvestila so namenjena društvenemu življenju. Obsegajo 1 stran.

5. Prispevek mora vsebovati **povzetek** in **izvleček.** Izvleček je krajši (cca. 10 vrstic) od povzetka (cca. 30 vrstic) in v nasprotju s povzetkom tudi ne vsebuje komentarjev in priporočil.

V *izvlečku* na kratko opišemo namen, metode dela in rezultate. Navedemo, čemu smo delo opravili ali napisali dokument. Na že objavljeno gradivo se sklicujemo le, če je to glavni motiv dela. Na kratko opišemo metode in tehnike dela - kolikor je potrebno za razumevanje. Nove tehnike opišemo le, kjer se razlikujejo od že znanih. Če v delu ne opisujemo eksperimentalnega ali praktičnega dela, opišemo vire informacij. Rezultate in zaključke lahko združimo. Kar se da informativno navedemo le, kaj smo ugotovili oziroma odkrili.

Povzetek začnemo s stavkom, ki vsebuje glavno sporočilo dela. Stavki naj bodo popolni in ne predolgi. Pišemo v tretji osebi, le izjemoma uporabimo glagole v neosebni obliki. Uporabljamo pravilni strokovni jezik in se izogibamo slabše znanim kraticam. Ohraniti moramo osnovno informacijo in poudarke iz glavnega besedila. V povzetku ne sme biti ničesar, česar glavno besedilo ne vsebuje.

6. Avtorji so dolžni definirati in pripisati ustrezne **ključne besede** (pod izvlečkom) članka. Zaželjeni so tudi **angleški (ali slovenski) prevodi** ključnih besed, podnapisov k slikovnemu in tabelarnemu gradivu. Priporočamo se še za angleški (ali slovenski) prevod povzetka, sicer bo za to poskrbelo uredništvo.

7. V besedilu se po možnosti držimo naslednjih poglavij:

1. Uvod.
2. Pregled dosedanjih objav.
3. Materiali in metode (Dokazni postopek).
4. Rezultati.
5. Razprava ali diskusija.
6. Zaključek (Sklepi).
7. Zahvala - če avtor želi.
8. Priloge - če je potrebno.
9. Literatura (Viri, Bibliografija).
10. Povzetek (Summary).
11. Izvleček.
12. Ključne besede (neobvezno).

8. Ločimo **vsebinske** in **bibliografske** *opombe.* Vsebinske opombe besedilo še podrobneje razlagajo ali pojasnjujejo, postavimo jih *pod črto.* Z bibliografsko opombo pa mislimo na citat - torej sklicevanje na točno določeni del besedila iz neke druge publikacije (navedemo tudi točno stran, kjer je citat objavljen) ali na publikacijo (članek) kot celoto (točne strani, kjer smo besedilo prevzeli, ne navajamo).

Bibliografsko opombo sestavljajo naslednji podatki:

Avtor, leto izida in - le če citiramo točno določeni del besedila - tudi navedba strani.

Celotni bibliografski podatki citiranih in uporabljenih virov so navedeni v poglavju *Literatura* (Viri, Bibliografija).

Primer citata med besedilom:

(Grafenauer, 1993, 11).

Primer navajanja vira kot celote, brez citiranja: (Grafenauer, 1993).

Popolni podatki o tem viru v poglavju Literatura pa se glasijo:

Grafenauer, B. (1993): Miti o "Istri" in resnica istrskega polotoka. V: Acta Histriae I. Koper, Zgodovinsko društvo za južno Primorsko, 9-52.

Če citiramo *več del istega avtorja iz istega leta*, poleg priimka in kratice imena napišemo še črke po abecednem vrstnem redu, tako da se viri med seboj razlikujejo. Primer:

(Grafenauer, 1993a); (Grafenauer, 1993b).

Bibliografska opomba je lahko tudi del vsebinske opombe in jo zapisujemo na enak način.

Posamezna dela ali navedbe virov v isti opombi ločimo s podpičjem. Primer:

(Gombač, 1996; Grafenauer, 1993b).

9. Pri **citiranju arhivskih virov** navedemo najprej arhiv, nato ime fonda ali zbirke in signaturo. V članku navajamo kratico arhivskega vira v oklepaju med besedilom. Kratico pa razložimo v poglavju o virih na koncu prispevka.

Primer navajanja arhivskega vira v oklepaju med besedilom: (PAK. RAG, 1)

Primer navajanja arhivskega vira v poglavju o virih: PAK. RAG - Pokrajinski arhiv Koper, Rodbinski arhiv Gravisi, a. e. (arhivska enota) 1.

Podobno poskušamo ravnati pri uporabi časopisnih virov.

10. Poglavje o literaturi in virih je obvezno. Bibliografske podatke navajamo takole:

- Opis zaključene publikacije kot celote - knjige:

Avtor (leto izida): Naslov. Zbirka. Kraj, Založba. Npr.:

Verginella, M., Volk, A., Colja, K. (1995): Ljudje v vojni. Druga svetovna vojna v Trstu in na Primorskem. Knjižnica Annales 9. Koper, Zgodovinsko društvo za južno Primorsko.

V zgornjem primeru, kjer je *avtorjev več kot dva*, je korekten tudi citat:

(Verginella et al., 1995)

Če navajamo določeni del iz zaključene publikacije, zgornjemu opisu dodamo še številke strani, od koder smo navedbo prevzeli.

- Opis prispevka v **zaključeni publikaciji** - npr. prispevka v zborniku:

Avtor (leto izida): Naslov prispevka. V: Avtor knjige: Naslov knjige. Izdaja. Kraj, Založba, strani od-do. Primer:

Verginella, M. (1995): Poraženi zmagovalci. Slovenska pričevanja o osvobodilnem gibanju na Tržaškem. V: Verginella, M. et al.: Ljudje v vojni. Druga svetovna vojna v Trstu in na Primorskem. Knjižnica Annales 9. Koper, Zgodovinsko društvo za južno Primorsko, 13-51.

- Opis članka v **reviji:**

Avtor (leto izida): Naslov članka. Naslov revije, številka. Kraj, Založba, strani od-do. Primer:

Gombač, B. (1996): Osvoboditev Trsta maja 1945. Annales 8/'96. Koper, Zgodovinsko društvo za južno Primorsko - Znanstveno-raziskovalno središče Republike Slovenije Koper, 141-150.

- opis ustnega vira:

Informator (leto izporočila): Ime in priimek informatorja, leto rojstva, vloga, funkcija ali položaj. Način pričevanja. Oblika in kraj nahajanja zapisa. Primer:

Baf, A. (1998): Alojzije Baf, r. 1930, župnik v Vižinadi. Ustno izporočilo. Magnetofonski zapis pri avtorju.

- opis vira iz internetnih spletnih strani:

www. home page ustanove (leto-mesec izpisa): celoten naslov podstrani. Primer:

www.zrs-kp.si (2000-07):
http://www.slo-istra.com/koper/zrs/zrs.html

Članki so razvrščeni po abecednem redu priimkov avtorjev ter po letu izdaje, v primeru da gre za več citatov istega-istih avtorjev.

11. Tiskarski znaki za poudarke naj bodo:
podčrtano za **polkrepko,**
valovito podčrtano za *ležeče.*
Računalniški zapis naj vključuje ustrezne oznake za bold in *italics.*

12. Kratice v besedilu moramo razrešiti v oklepaju, ko se prvič pojavijo. Članku lahko dodamo tudi seznam uporabljenih kratic.

13. Pri **ocenah publikacij** navedemo v naslovu prispevka avtorja publikacije, naslov, kraj, založbo, leto izida in število strani (oziroma ustrezen opis iz točke 10).

14. Prvi odtis prispevkov uredništvo pošlje avtorjem v **korekturo.** Avtorji so dolžni popravljeno gradivo vrniti v treh (3) dneh. Besedilo popravljamo s korekturnimi znamenji, ki jih najdemo na koncu Slovenskega pravopisa (1962), Ljubljana, ali v: Slovenski pravopis 1. Pravila (1990). Ljubljana, SAZU-DZS, 13-14.

Širjenje obsega besedila ob korekturah ni dovoljeno. Druge korekture opravi uredništvo.

15. Uredništvo prosi avtorje, naj navodila vedno upoštevajo. Ob vseh nejasnostih je uredništvo na voljo za vsa pojasnila.

UREDNIŠTVO

INSTRUCTIONS TO AUTHORS

1. ***ANNALES:*** *Annals for Istran and Mediterranean Studies - Anali za istrske in mediteranske študije* (up to No. 5: *Annals of the Koper Littoral and Neighbouring Regions - Anali Koprskega primorja in bližnjih pokrajin*) is a scientific and research interdisciplinary review covering the humanities, sociology and natural science in the area as stated in the review's subtitle.

2. Articles (papers) written in Slovene, Italian, Croatian and English languages will be accepted. The Editorial Board reserves the right to have them linguistically revised and corrected.

3. Articles should be written on max. 24 pages with double spacing and on one side of the sheet only. On the left side of each page, a 3-4 cm wide margin is to be left. Original photographs, drawings and tables are welcomed, as well as diskettes containing the texts, together with reference to the programme used.

4. Title page of typescript is to include title and subtitle of the article (paper), author's name, any (academic) titles and name of institution by which employed or personal address with eventual E-mail address.

Articles are arranged in the following eight **categories:**

Original scientific papers containing not yet published results of the author's own research. Such works will be reviewed by scientists chosen by the Editorial Board. Authors oblige themselves not to offer their material to any other journal or magazine.

Review articles bearing the character of original works. These are critical and detailed reviews of literature from various interesting fields of research.

Preliminary communication and Materials also bearing the character of original works.

Professional papers presenting results obtained through research. They too will be reviewed, and authors oblige themselves not to publish them elsewhere.

Reports include short scientific information on integral research work or a short description of scientific or specialist books or meetings of experts. Such articles are not to exceed 5 pages.

Youth research compositions are to be presented in the same was as research works.

Explanatory comments include topical issues from various fields of research and are not to exceed 2 pages.

Notices include news from various associations and should not exceed 1 page.

5. Articles should include both **summary** and **abstract.**

Abstract is the shorter of the two (with up to 10 lines) and does not include, in contrast to summary (with up to 30 lines), explanatory comments and recommendations.

Abstract is to contain a short description of the purpose and methods of the work and its results. Author should also state why the work has been carried out and why a document has been written about it. References to the already published material are made only if this is the main purpose of the work. Methods: if necessary, work methods and techniques are to be briefly described (new techniques are to be stated only if differing from the already known ones). If no experimental or practical work is described, sources of information are to be given. Results and conclusions may be incorporated. Findings are to be presented as briefly as possible.

At the beginning of summary the essential points of the carried out work are to be presented. Sentences should be concise and not too long. The text is to be written in the third person; verbs may be used in impersonal form only exceptionally. The not so well known abbreviations are to be avoided. Summary is to retain the basic information from the main part of the text, and should not contain anything that does not appear in the main text itself.

6. Authors are obliged to define and state **key words** (below abstract) in their articles. **English (or Slovene) translation** of key words, texts accompanying figures and tables are welcomed, as well as English (or Slovene) translation of abstracts; if this is not convenient, the Board of Editors will provide for it.

7. Texts should include, if at all possible, the following chapters:

1. Introduction
2. Works published to date
3. Material and methods
4. Results
5. Discussion
6. Conclusions
7. Acknowledgements (if desired by author)
8. Supplements (if necessary)
9. References (Sources, Bibliography)
10. Summary
11. Abstract
12. Key words

8. Two kinds of *notes* are distinguished: those regarding the **contents** of the text, and those referring to **bibliography.** The first elucidate the text in even greater detail and are to appear *at the bottom of the page (under line).* Bibliographical notes, which are to appear in brackets in the text itself, deal with quotations and refer to a precisely stipulated part of the text from some other publication (the page on which quotation appears is to be therefore stated as well) or to a publication (article) as a whole (in this case no page from which the text has been taken is to be stated).

Bibliographical notes are made up of the following details:

Author, year of its publication, and page (but only if a precisely stipulated part of the text is quoted).

The entire bibliographical data of the quoted and used sources are to be stated under *References* (Sources, Bibliography).

Example of quotation referring to a precisely stipulated part of the text: (Sommerville, 1995, 11).

Example of source quotation as a whole, with no citation: (Sommerville, 1995).

The entire data of this source are to be stated in the references and sources chapter as follows:

Sommerville, M. R. (1995): Sex and Subjection. Attitudes to Women in Early-Modern Society. London-New York-Sydney-Auckland, Arnold.

If a number of works *by the same author from the same year* are quoted, letters in alphabetical order are to be stated apart from the author's surname and abbreviation of his first name, in order that the sources are clearly divided between each other. Example:

(Sommerville, 1986a); (Sommerville, 1986b).

Bibliographical note can also be a part of the note referring to the contents and is to be written in the same way, i.e. in brackets within the note referring to the contents.

Separate works or source quotations under the same note are to be separated with semicolon. Example: (Sommerville, 1986b; Caunce, 1994).

9. When **quoting archive sources,** the archive is to be stated first, then the name of the fund or collection and shelfmark. The abbrevation of archive source is to be stated in brackets in the text of the article. The abbrevation is to be explained in the references chapter at the end of the article.

Example of citing archive source in brackets in the text itself: (ASV. CSM, 240).

Example of citing archive source in the reference chapter: ASV. CSM - Archivio di Stato di Venezia. Cinque Savi alla Mercanzia, fasc. 240.

Review sources are to be stated in the same way.

10. The **references and sources** chapter is compulsory. Bibliographical data are to be stated as follows:

- Description of **integral publication:**

Author (year when published): Title. Volume - Collection. Place of publication, published by. Example:

Caunce, S. (1994): Oral History and the Local Historian. Approaches to local history. London and New York, Longman.

If there are *more than two authors,* the work can be also cited as:

(Matthews et al., 1990, 35)

If a specific part from an integral publication is quoted, the page numbers from which the quotation has been taken are to be added to the above description.

- Description of the **article (paper) in integral publication** - e.g. text in a collection of scientific papers: Author (year of its publication): Title of the paper. In: Author of the book: Title of the book. Volume - Collection. Place of publication, published by, pages from - to. Example:

Matthews, R., Anderson, D., Chen, R. S., Webb, T. (1990): Global Climate and the Origins of Agriculture. In: Newman, L. F. (ed.): Hunger in History. Food Shortage, Poverty, and Deprivation. Oxford-Cambridge, Blackwell, 27-55.

- Description of **article in certain review:** Author (year of its publication): Title of article. Name of review, its number. Place of publication, published by, pages from - to.

Example:

Sluga, G. (1996): Identity and Revolution: The History of the "Forty Days" of May 1945. Annales 8/'96. Koper, Zgodovinsko društvo za južno Primorsko - Znanstveno-raziskovalno središče Republike Slovenije Koper, 125-140.

- description of personal communication:

Informant (year when communication was given): Name and surname of informer, year of birth, function or position held. Manner of the testimony's presentation. Form and place where record was made. Example:

Baf, A. (1998): Alojzije Baf, 1930, priest at Vižinada. Personal communication. Tape recording at author's place.

- description of source from the Internet websites:

www. home page of institution (year-month when registered): full address of sub- page. Example:

www.zrs-kp.si (2000-07):

http://www.slo-istra.com/koper/zrs/zrs.html

If the same author(s) is (are) cited a number of times, the articles are to appear in alphabetical order of the authors' surnames and year of publication.

11. Printer's marks for accentuations are to be as follows:

underlined for **semi-bold,**

undulatory line for *italics.*

Computer notation is to include suitable marks for bold and *italics.*

12. Abbreviations in the texts are to be explained in brackets when appearing for the first time. A list of used abbreviations can be added to the article.

13. When **assessing a publication,** its author, title, place, publishing house, year of publication and page numbers (or appropriate description from Item 10) are to be stated in the title of the article.

14. First copies of printed articles will be sent to authors for **proof-reading.** Authors are obliged to return them in three (3) days. No new sentences are allowed to be added during proof-reading. The second (printing) proofs will be read by the Editorial Board.

15. Authors are kindly requested to consider these instructions at all times. In case of any indistinctness, please do not hesitate to contact the review's Editorial Board.

EDITORIAL BOARD

Banka Koper

SKUPINA ISTRABENZ

LUKA KOPER

Adriatic
Zavarovalna družba d.d.

Casinò
PORTOROŽ - PORTOROSE
SLOVENIJA

Delamaris®
1879

DROGA
PORTOROŽ
Živilska industrija d.d.

ELEKTRO PRIMORSKA

Intereuropa®
Mednarodna špedicija, transport
in pomorska agencija d.d. Koper

5
MAKRO

Telekom
Slovenije

GRAFS
TRADE D.O.O.

Koprski Vinorodni Okoliš
VINAKOPER